1911 • FIFTY YEARS OF SERVICE TO COAL MINING • 1961

COAL AGE

JULY, 1961

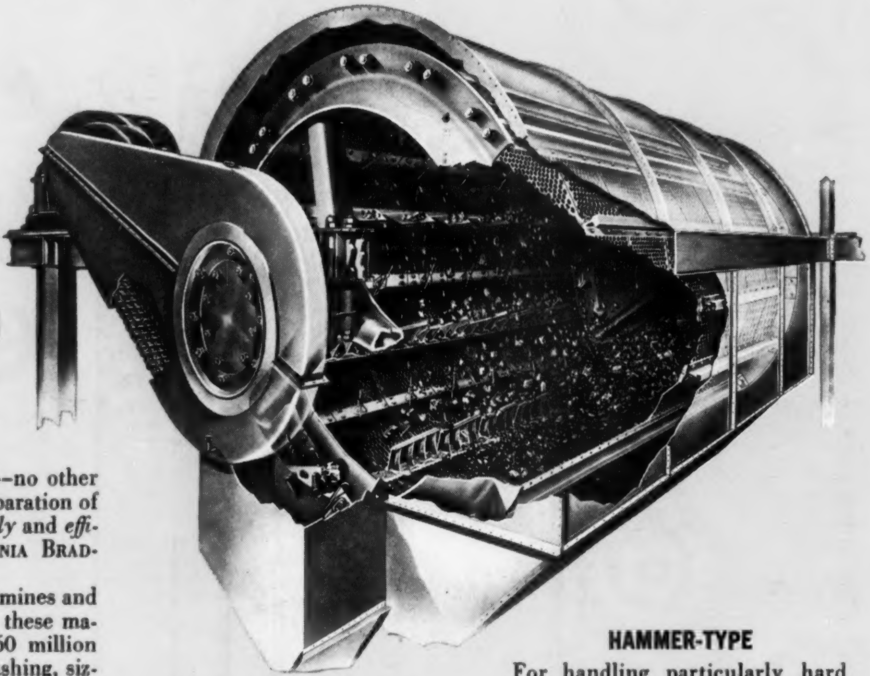
PRICE $1
A McGRAW-HILL PUBLICATION

IN THIS ISSUE . . . p169

"EFFICIENCY FOR PROFIT"

THE MINING GUIDEBOOK

For maximum economy in preparation of ROM coal—it's PENNSYLVANIA BRADFORD BREAKERS



Trunnion-mounted
Roller-mounted
Hammer-type

Mine-side or plant-side--no other crusher handles the preparation of ROM coal as *economically* and *efficiently* as a PENNSYLVANIA BRADFORD BREAKER.

At power plants, coal mines and by-product coke plants, these machines prepare over 160 million tons of coal a year—crushing, sizing and scavaging all in one continuous operation, at capacities up to 1500 TPH, and at average maintenance costs as low as $.001 per ton and power consumption averaging .204 KW per ton.

ROM coal is continuously charged at loading end. Passing sizes are immediately screened out. Larger lumps are raised by radial lifting shelves and dropped, breaking along natural cleavage planes to desired screen size, with minimum fines.

Refuse such as bony, sulphur balls, slate and rock, resist breakage, are automatically discharged at the refuse end along with tramp iron, timbers, etc.

ROLLER-MOUNTED

Roller-mounted BRADFORD BREAKERS are particularly adapted for use at coal mines, as the spider at the loading end is designed to permit loading of extra large lumps of coal.

TRUNNION-MOUNTED

Trunnion-mounting, where the revolving cylinder is suspended on trunnions, is the popular type for plant-side installations.

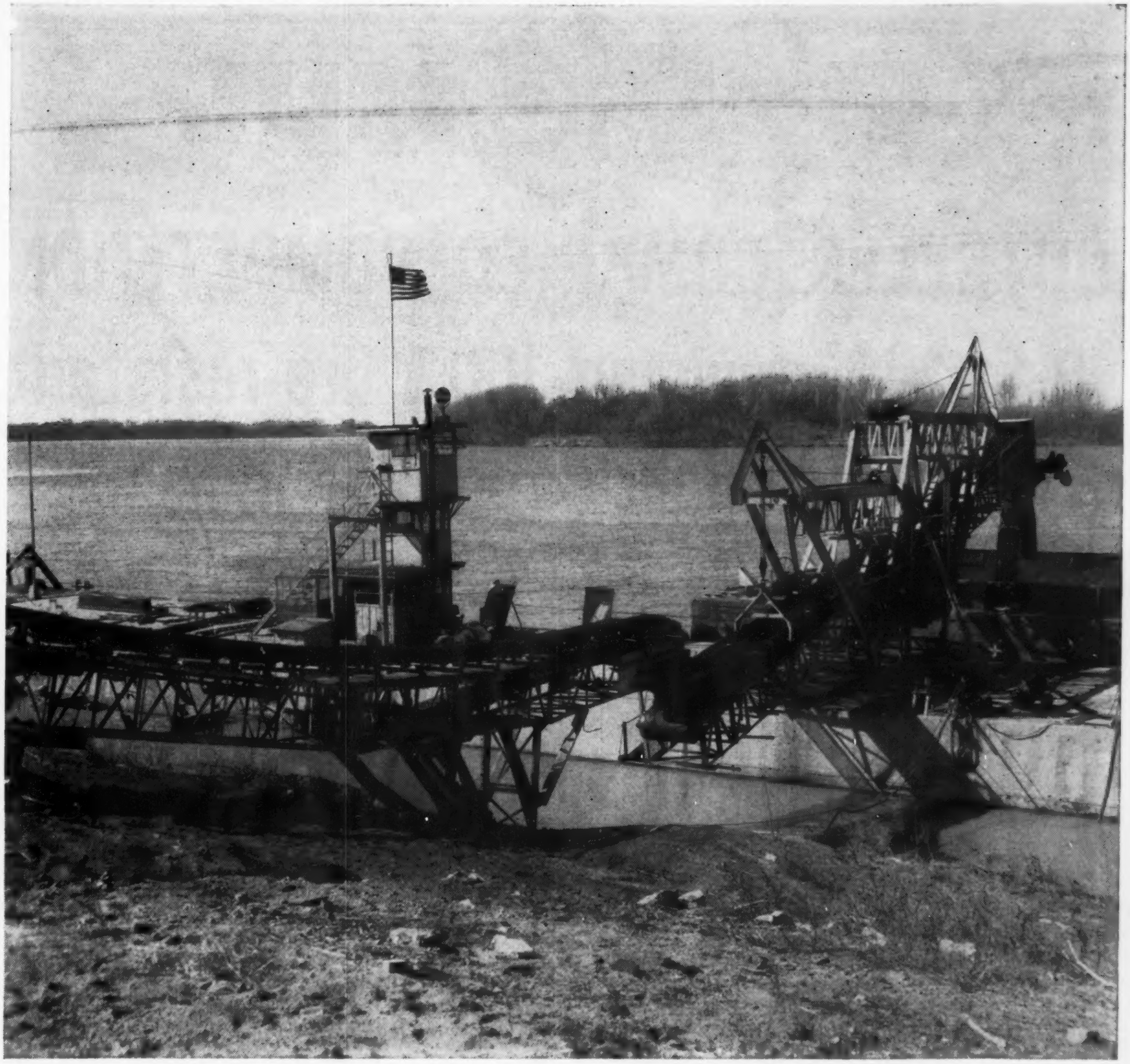
HAMMER-TYPE

For handling particularly hard coals, or for heavier loading, the BRADFORD BREAKER is combined with a concentrically-mounted rotor of a hard-hitting PENNSYLVANIA HAMMERMILL at the rear end of the breaker.

Whatever the type most suitable for your need, if it's *economy* and *efficiency* you want—investigate PENNSYLVANIA BRADFORD BREAKERS. Write for catalogs, or call a Pennsylvania Engineer.

PENNSYLVANIA CRUSHER DIVISION
BATH IRON WORKS CORPORATION
WEST CHESTER, PENNA.

PENNSYLVANIA
BATH-BUILT
CRUSHERS



Coal runs the 8-minute mile from mine to river

THIS is the payoff end of a mile-long conveyor system that rushes 1200 tons of coal an hour from a Kentucky mine to the Ohio River. While barges are being loaded, the belts often work 40 hours at a stretch—are exposed to sun, rain, ice, and a steady stream of wet, sharp coal.

To stand the heavy loads, and to maintain 600 feet-per-minute speeds, the engineers in charge selected two B.F.Goodrich cord belts. Unlike other belts, made of rubber and layers of fabric, the BFG cord belt is made with cords running lengthwise, buried in the rubber. The parallel cords add extra strength to a belt, yet are flexible so that troughing is natural, belt keeps centered on idlers, spillage is held to a minimum.

The B.F.Goodrich belts were installed in 1953. Since then, they've hauled an estimated 14 million tons to the river. No time has been lost due to maintenance and repair. In fact, according to one mine official, you can hardly tell the belts have been used.

Your B.F.Goodrich distributor can give you full information about the cord belts used in this conveyor system. And, because he's a factory-trained specialist in rubber products, he can answer your questions about the many rubber products B.F.Goodrich makes for industry. *B.F.Goodrich Industrial Products Co., Dept.* ***M-144,*** *Akron 18, Ohio.*

B.F.Goodrich

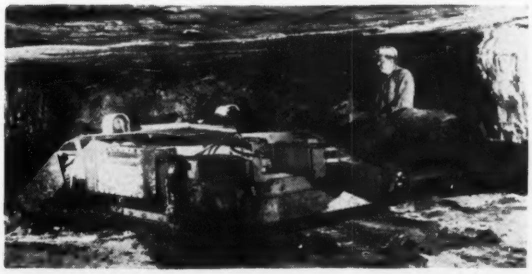
CONVEYOR BELTS

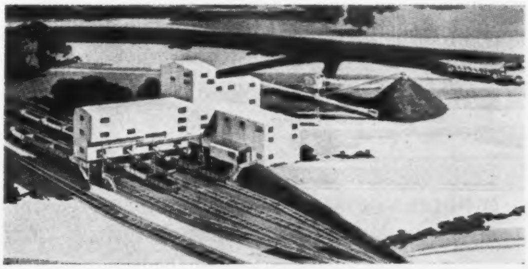
This Month in COAL AGE

July, 1961

Features:

Departments:





Deep Mining

Getting 108 Tons Per Face Man p 72

Production of 108 tons of raw coal per face man, an outstanding safety record and systematic equipment inspection are highlights of operations at Glen Castle mine, Hanna Coal Co., Cadiz, Ohio. In achieving this high level of productivity in off-track sections throughout 1960 and thus far in 1961, Glen Castle has reduced its accident frequency rate to 4.05 and severity rate to 0.37. Equipment downtime averages only 3.71% of available working time.

Complicating the matter is the existence of worked-out, water-filled mines surrounding the Glen Castle property. Initial work was concentrated at lower elevations to create sumps. A new slope opening the property eliminated a long haul through older workings, eliminated long water lines to discharge acid water and permitted the use of larger mine cars.

Stripping, Preparation

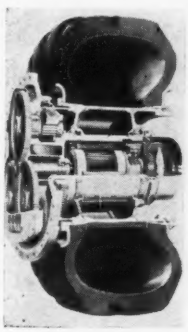
Allendale: Stonefort's Newest .p 80

New producer in Stark County, north of Peoria, now adds 2,900 tpd of low-ash, free-burning No. 6 coal to fuel supply of Midwest for industrial, commercial and public-utility uses. Plant is designed for rotary-breaker rough cleaning, raw-coal storage, washing, thermal and mechanical drying, oil treating and precise sizing. Coal-Pak heats preparation plant; other service buildings are electrically heated. Galvanized steel with plasticized coating is used as sheathing on Allendale buildings.

Haulage

R. W. Volpe, General Electric Co.

Applying Electric Drive to Coal Haulers ... p 90



Every year brings announcements of new, larger shovels in strip mining. In haulage, also, truck size has increased in definite steps, always under the pressure of economics. The only basic modification has been the increase in capacity. Performance as measured in horsepower per gross ton and maximum geared speed has not been improved appreciably. Electric drives offer increases in performance to match increases in capacity. Among the types are motorized-wheel, diesel-electric and trolley-powered machines.

(Continued on p 7)

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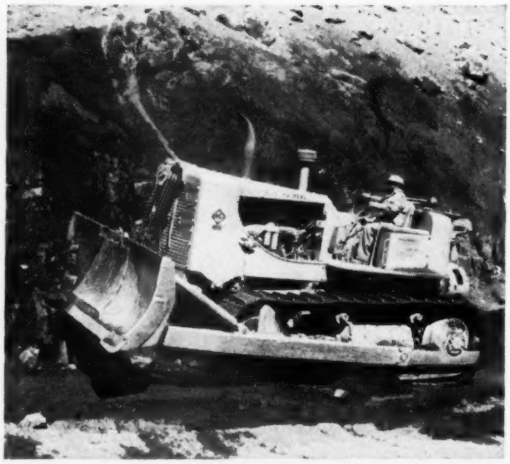
End Bits, Dipper Teeth and Welding Rods

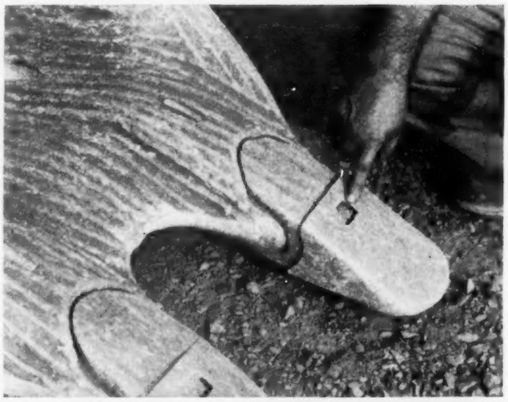
for the mining industry



Amsco doesn't build tractors or shovels. We leave that to the tractor and shovel specialists. But, we do build a full line of impact and abrasion resistant alloys for these machines that help you reduce wear problems.

No matter how dense or abrasive the material you're moving, there's a special Amsco alloy that's just right. For example:

END BITS— New Amsco "CS" multiple alloy steel end bits have a tensile strength of 220,000 psi, yield strength of 195,000 psi and a hardness of over 400 Brinell. Dozing in dirt, sand and rock they have given 2 to 3 times the service life of competitve products while maintaining sharp cutting edges. You can get them for all major bulldozer blades. We also make a line of track shoes, grousers and weldments, rollers, sprockets and rims and idlers for all major crawler tractors.



DIPPER TEETH— "Simplex" two-part reversible point dipper teeth last 2 to 4 times longer. A special pin lock assures positive locking of the reversible tip and reversing takes only minutes on each dipper. A new heat treated alloy is used in them—a tough metal that withstands extreme abuse from impact and abrasion.

WELDING RODS— A complete line of Amsco electrodes and weldments is available for build-up and repair, led by the famous "Pair for Wear" which handles 90% of your hardfacing requirements. Nicro Mang* is a 14% manganese steel electrode that eliminates, at less than half the cost, the use of a "buttering pass" of stainless when welding manganese to carbon steel. Its partner is the X-53, an all-purpose electrode for general hardfacing. A sample kit containing both of these new rods is yours for the asking.

If wear is a problem on your job, see your nearest Amsco representative or dealer for end bits, dipper teeth, welding rods, shovel buckets, crusher wear parts and other products for the Mining industry.

*TRADEMARK REGISTERED

1361

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AMSCO

AMERICAN MANGANESE STEEL DIVISION
CHICAGO HEIGHTS, ILLINOIS

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Denver • Los Angeles • New Castle, Delaware
Oakland, California • St. Louis
IN CANADA: Joliette Steel and Manitoba Steel Foundry Divisions
IN MEXICO: Amsco Mexicana, S.A.

Taxes

D. M. Gamet and **M. F. Faillace**, Arthur Andersen & Co.

The concept of "exploration expense" dates back to 1951 but the Congressional definition is very general in its terms and the rules therefore are arbitrary and appear at times capricious. In many instances securing of a tax benefit will be solely dependent upon technicalities. However, the developer who builds a careful record to support his construction-decision date should be able to establish a much-earlier line between exploration and development, and thus escape much of the adverse effect of the limitations on exploration expense.

For Specific Situations—Twenty-seven cases covering the major exploration-expense situations.

Transportation

Electric utilities are expected to be the main objectives in coal pipeline construction. The original line from Georgetown, Ohio, to E. Cleveland is routinely delivering around 1¼ million tons a year. No definite location has been fixed for a second line, but one from northern West Virginia to the East Coast is being considered, as well as others. New lines probably will transport "stabilized slurry," a mixture of 60% coal and 40% water, which can be burned directly in cyclone furnaces, and also in pulverized-coal installations with minor modifications. And these new lines probably will be at least 20 in in diameter and deliver a minimum of 6 million tons a year for lowest costs and maximum savings.

Maintenance Ideas

Electrical controls must be properly applied and installed, and correctly maintained to obtain trouble-free service. Some of the difficulties common to electrical controls are pointed out in this article by Allis-Chalmers Mfg. Co. It also includes a troubleshooting chart and a preventive-maintenance check list to serve as a guide in setting up a thorough maintenance program.

(Continued on p 9)

This Month in COAL

30 MILLION BEHIND—Bituminous coal production succeeded in cracking the 8-million-ton ceiling in June a little ahead of the vacation shutdown. But tonnage was better than 30 million behind the total in the same period in 1960, leaving as the big question: Can this gap be made up in the last 6 mo? To do it would require an average weekly output (vacation excluded) of 9,300,000 million tons, compared to 7,300,000 million in the first half, and 7,900,000 in the last half of 1960. A real forward surge in business could do it, but the betting among most of the coal fraternity is not over 400 million for 1961, with some of the more pessimistic going as low as 360, meaning a last half of no gain over the first.

ANTHRACITE UP—The continued southward displacement of the upper air streams, with consequent continuation of cooler-than-normal weather, brought anthracite through the first half approximately equal with the first half of 1960. Again it is worth noting that this is the first such a situation for quite a few years. If the displacement persists, anthracite might make it for the year too.

ANOTHER GO AT GAS—Rep. Oren Harris, of Arkansas, is the moving force behind another attempt to straighten out the tangled web of federal natural-gas regulation. The medium is a comprehensive natural-gas bill offered June 9, which puts the question up to the Congress for the time being. What the Congress will do is naturally a guess, but in any event field prices of natural gas will remain subject to some form of control. However, it seems likely that the lid will not be clamped down as tightly, and the net effect should be to make it easier to hike prices. Coal can look forward, as a matter of fact, even if no law is passed, to higher delivered prices for gas and thus an easing of competitive pressure from that particular direction, though the easing will continue to be gradual.

FOREIGN OIL—Present residual and crude imports into the U. S. are a known problem as far as competition for coal is concerned. The problem that may be presented by oil moves elsewhere around the world is as yet largely unknown. Along with movement from the older Near East fields, there is also the prospect of large production in the Sahara, while Russia and other Communist countries are already pushing into Europe. Though it is no sure thing yet, one effect could be to narrow the European market for at least some types of U. S. coal. Second, Communist dumping could result in forcing other oil to seek new outlets, the most-logical one being in the U.S. So the pressure to force more oil onto the two Coasts could increase. In general, however, oil's threat is likely to continue secondary to that of gas—for the present at least.

IN CONGRESS—It is now apparent that if there ever was a hope for a reduction in the federal tax burden, the New Frontier spending plans have effectively blighted it. Congress is appropriating more money and at the same time killing off proposals to cut rates and eliminate such special taxes as that on travel. And in the light of all this it is not likely to do anything about such things as depletion rates for coal. But it now appears that approval of a fuels-policy study is close to being in the bag.

Industry Affairs

Broadening impact by coal's reorganized association reported at Washington convention of NCA. Proceedings of committee deliberations on government relations, marketing, research, economics and public relations illuminate a year of progress and show industry recognition of challenges ahead. Coal exporters note world-wide interest in America's high-quality coals.

Starting with a survey of developments since the first edition in 1955, plus a look ahead to 1965, the seventh *Coal Age* Mining Guidebook in this issue again gives you the basic fundamentals complemented by the latest in equipment, methods and materials.

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THIS MONTH . . .

In Mining Practice

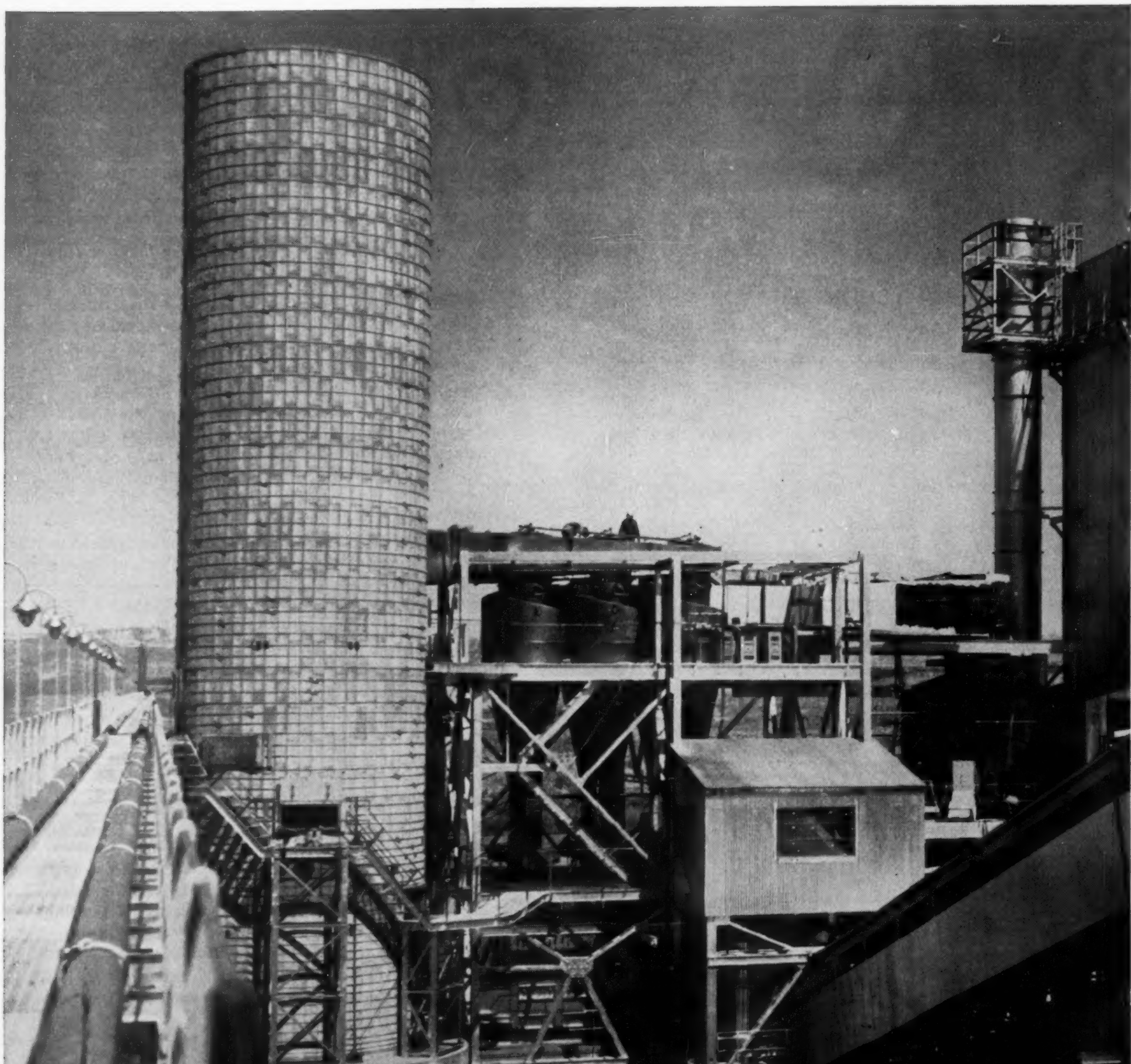
MACHINE UTILIZATION—The rising costs of underground machines—in large part reflecting new designs and higher horsepower for greater output per shift—is quite naturally reflected in a rise in writeoff per ton, accentuated by the fact that the art is still improving at such a rate that obsolescence is the major reason for replacement rather than "normal" wearout. One answer is more operating shifts per year, and its attainment is more and more a pressing matter, which is receiving more and more study in operating circles as well as manufacturing. Even a 10% increase in operating time as a result of better maintenance, could cut machine cost up to 5¢ a ton or more in many instances.

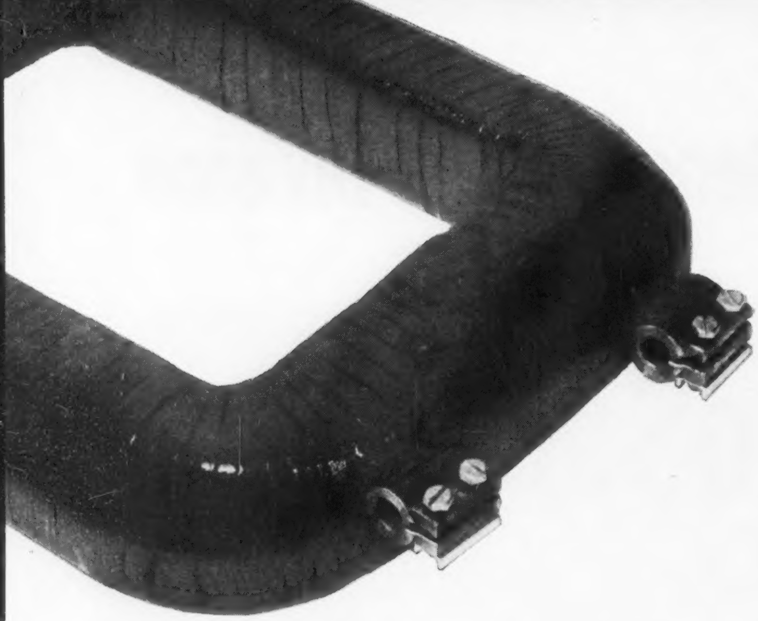
MORE FLOW, BETTER RESULTS—The rising interest in flotation as a means of simplifying and reducing the cost of water-handling circuits also has brought about some new thinking on the general problem of operating flotation cells. Solids concentration in waste water naturally tends to be low, and it has been found that the higher water content results in more-effective flotation, other things being equal. Now, the principle is being pushed for coal-recovery and treatment plants as well as water-handling units.

BIGGER AND BETTER—It has technically been possible for some time to bore shafts up to 20 ft or more in diameter. Actually, however, the difficulties increased geometrically after diameter reached 5 to 6 ft, and drilled shafts larger than that have been few. But, as in everything else, improved design and especially improved drilling heads and bits have widened the horizon. Now, several concerns offer their services for bores up to 15 ft in diameter and say that 20 ft or more is perfectly possible. Conclusion: Shaft costs may be down rather sharply in the not-too-distant future.

TWELVE NOW—A recent check by COAL AGE shows twelve deep mines now completely on USBM-approved nonflammable hydraulic fluid—all of the emulsion type. Quite a few others are experimenting or have up to one or two sections completely changed over. Experience? It has varied widely in the past depending on the fluid and how it was used, the latter in turn bringing in user training, and the characteristics of the fluid and how to get the most out of it. The twelve 100% mines report to COAL AGE that operation is quite satisfactory in all respects, including cost of fluid and pump wear. Their experience indicates that with the right fluid rightly used the industry will find itself preferring the nonflammable type rather than using it under orders.

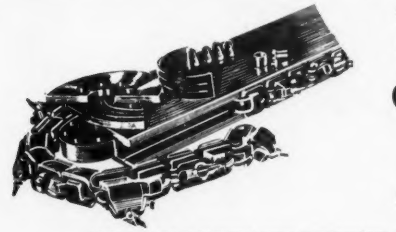
GOOD ENOUGH—Power factor seldom appears in coal discussions, particularly those where operating men predominate. But the increase in the use of AC underground, as well as the general rise in induction-motor load, make it still a most worthwhile object of check and study. Even if penalty is being avoided by capacitors at a main substation the job may not be completely done, since up to some miles away poor power factor may be loading up distribution circuits with adverse affects on cables and the like. Now in addition to other means, there are simple low-cost indicators for checking on the situation throughout the property.





New SUPER-STRONG No. 80 CUTTERBAR

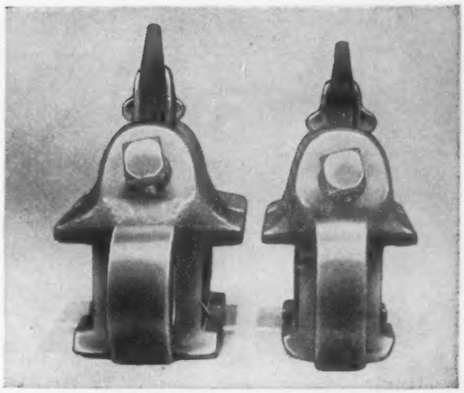
built to fit all of the newest heavy-duty machines, designed for use of the stronger new Bowdil



CHAIN #40-3

ALSO USED ON CONTINUOUS MINING MACHINES

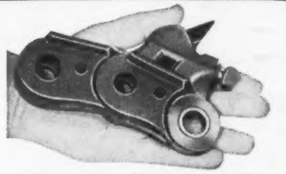
AVAILABLE WITH BIT OPENING ½" x 1" (takes all type bits)



new #40-3 standard #40-1

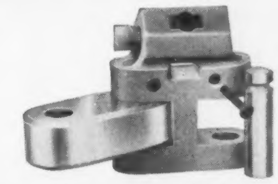
SPROCKETS FOR ALL MINING MACHINES

Bowdil Sprockets are made from special heat - treated alloy steel. Our stock of over 100 different styles includes clutch, spline and keyed types—various tooth designs of 4 to 13 teeth.



New Small, Versatile
"THIN-KERF" CHAIN and CUTTERBARS

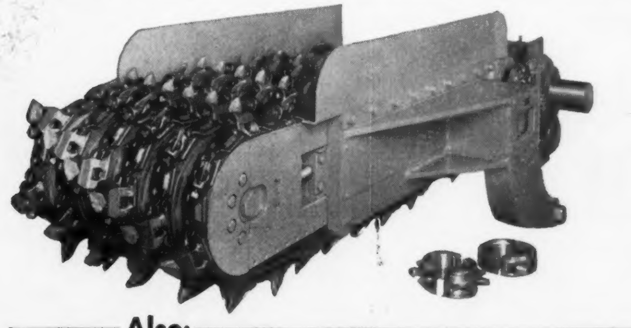
Lends itself best to use on machines delivering up to 15 h.p. and kerf of 3" to 3½". Reduces amount of cutting to the point where higher feed speeds are realized . . . and CLEANER CUTS!



Newest type TRIMMER CHAIN

for all makes of CONTINUOUS BORING MACHINES

Great strength and flexibility. Uses Bowdil Throwaway or ½" x 1" Shank Bits. Chain pitch may be varied by changing couplers only. NOTE COUPLING PIN DESIGN . . . chains may readily be assembled or disassembled with use of small hand tools.



6-IN-ROW RIPPER HEAD

Using 6 renewable independently adjusted Cutterbars, with all 6 Chains similar in kerf and lacing arrangement for interchangeability. All 6 sprockets interchangeable. Improved design head drive shaft and sprocket assembly using 2 piece sprockets to maintain extreme tension to the shaft.

These are only a few of the features and advantages in this modern Ripper Head for Continuous Mining. Ask a Bowdil representative or write for more detailed information.

Also:

"No-Bend-'em" Spike Pullers

"Changeable-Points" Hand Picks

"No-Tools-Needed" Rope Sockets

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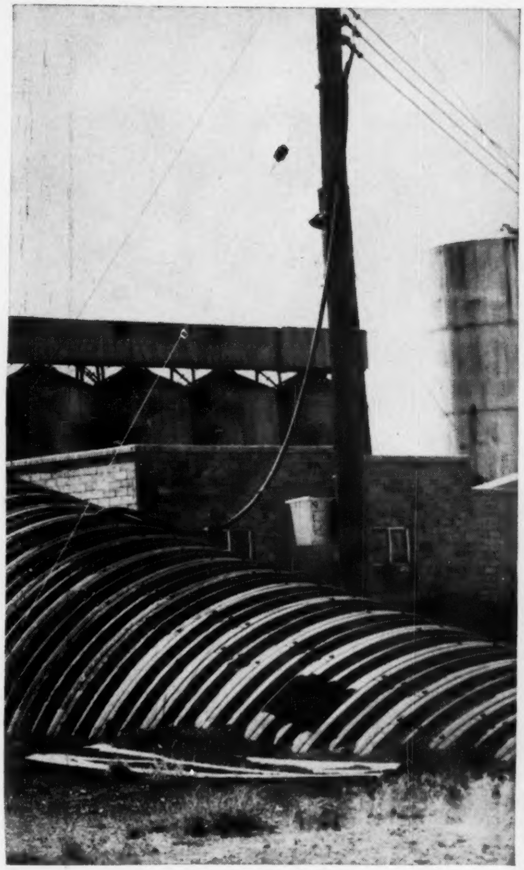
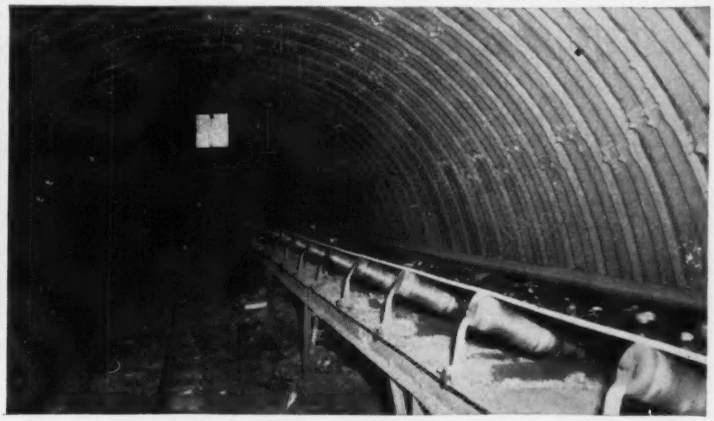


By splitting the main entry conveyors at this point and using a 1,023′ and a 964′ conveyor to lift coal from the 460′ level to the tipple, Barber-Greene conveyor engineers saved the mine owners $40,000 in initial investment.



All six belts in the present conveyor system are 12 years old, none having been replaced. Conveyor performance has been equally outstanding, only 20 carriers and return rolls requiring replacement since 1949.

NO BELT REPLACEMENTS, IDLER MAINTENANCE

Only 20 carriers and return rolls out of more than 2,500 on the job have needed to be replaced."

You can quickly discover how this same imaginative Barber-Greene approach to belt conveyor system design can work to your benefit. Simply call in your Barber-Greene conveyor specialist for a quote on the system you are planning. Chances are you can duplicate the experience of the Clayton Coal Co. and save money two ways – on system design and on performance over the years. Whether your job calls for standard equipment, specially engineered equipment, or a combination of both, your quote will reflect more than 40 years of belt conveyor experience.

Your belt conveyor equipment headquarters

Representatives in Principal Cities of the World

Barber-Greene BG

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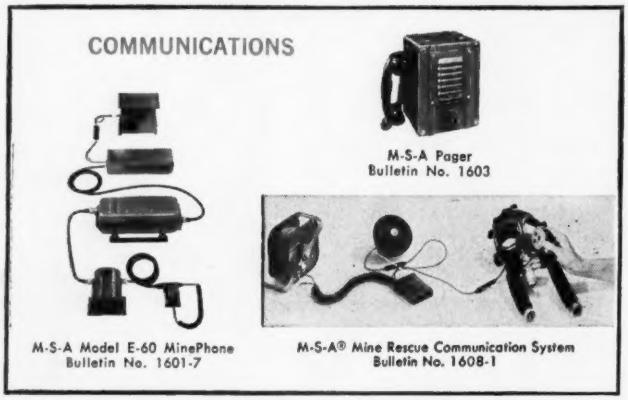
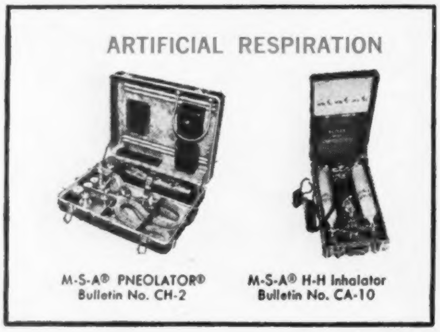
CONVEYORS • LOADERS • DITCHERS

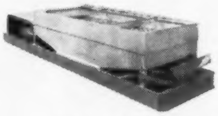
ASPHALT PAVING EQUIPMENT

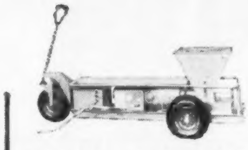




Miners work safely, operators get greater tonnage with complete MSA product lines. With these MSA products on the job, men and machines mine more coal safer, thriftier, and more efficiently than ever before possible. MSA serves mining everywhere with conveniently located warehouses and complete lines of safety equipment. When you have a safety problem, look to MSA for a solution.

ROCK DUSTING AND DUST COLLECTING


M-S-A Air Slide Rock Dust Distributor
Bulletin No. 1201-7


M-S-A® Bantam 400 Rock Dust Distributor
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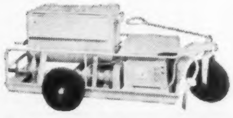
M-S-A® Slurry Rock Dust Distributor
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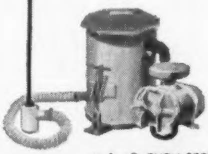
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RESPIRATORY PROTECTION


M-S-A® Self-Rescuer®
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METHANE DETECTION


M-S-A® Methane Alarm
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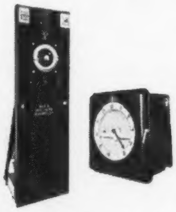
M-S-A® Methane Recorder
Bulletin No. 0706-1


M-S-A®-Wolf Junior Flame Safety Lamp
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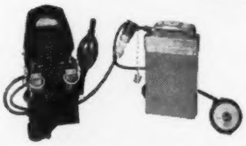
M-S-A® Methane Detector Type W-8
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M-S-A® Methane Tester Type M-6
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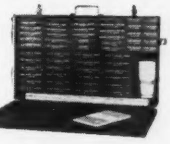
FIRST AID EQUIPMENT


M-S-A® Miner's First Aid Cabinet
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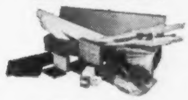
M-S-A® Jenkins Stretcher
Bulletin No. 0408-10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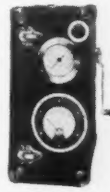
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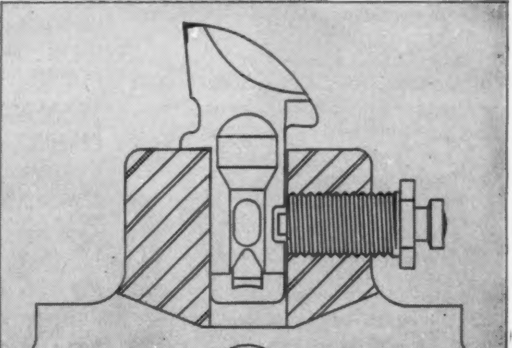
RSS QUICK CHANGE Cutter Bit slashes bit changing time 85%

For fast, easy bit changing, try the new Carmet® RSS Quick Change Cutter Bit with keepers in JOY V-type chains. Simply pry set screw plunger outward to retracted position (cutter bit is released instantly)—remove bit with free hand—replace bit—release plunger. Changing time is reduced 85%! Bit changes are just as fast in Bit Rings and Borer Blocks.

RSS Cutter Bits are designed for positive locking with JOY keepers. The threaded keeper plunger engages a forged notch in the tool shank, keeps the cutting tools locked firmly in place. No wobble, no battering of tool shank on keeper, no tools jerked out and lost.

And the RSS Cutter Bit is built to take abuse . . . with a beefed-up, load-bearing shoulder area that withstands higher cutting pressures . . . a plug-type carbide insert set at an angle that eliminates braze failure and insert loss . . . a full radius tip design that fully supports the insert, reduces breakage, permits harder grades of carbide.

The carbide, of course, is Carmet carbide . . . famous for quality. In fact, Carmet Division manufactures the complete mining tool, and their reputation depends on Carmet Tools being the finest available. There's a Carmet Bit designed for universal machines and continuous miners of every make, and your Carmet distributor carries a complete line in stock for prompt delivery. Call on him for help with your mining tool problem. *Allegheny Ludlum Steel Corporation, Carmet Division, Ferndale, Detroit 20, Michigan.*



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News Roundup

Cheap Gas From Canada?

Will Canadian gas be cheap, and thus pose a major competitive threat to coal in the U. S. as a result of increased importations?

Because enormous gas reserves exist in western Canada, an affirmative answer might seem in order. But the experience of at least one gas distributor — the Montana Power Co.—indicates that the answer is not in the affirmative. With the Montana fields it has been relying on now depleted, it has turned to Alberta for gas, and as a result of increased cost, has had to apply for major rate increases immediately, with others in prospect in the future. Coal men in the state, in fact, are looking forward to regaining at least some of their markets, while Montana Power is striving mightily to convince the public it should stay with gas.

Its case, and some of the hard facts of increased costs to customers, which make comforting reading for coal men, is set forth in its own words, as follows:

"For 30 yr, The Montana Power Co. has been supplying natural gas to the people of Montana, bringing them fine service at the lowest possible cost. During this 30-yr period, we have reduced our rates twice and only in 1953 did we find it necessary to increase our rates although our costs have increased enormously over the years.

"Throughout these years, our customers have been using up our supplies of low-cost gas which now must be replaced by gas at higher prices. We have contracted for this additional gas from the Alberta & Southern Gas Co., Ltd., and although it is the lowest-priced gas available to us, we face substantial increases in cost.

"We must obtain this gas to assure you continued service and adequate supplies for your present and future needs. And it is important to you that we receive a proper rate for this gas because, unless we do receive a proper rate, we cannot buy the gas and you, as a customer, will suffer. Without an assured supply of gas, it would not be long until you would be required to convert to another more expensive, less convenient fuel.

"Because of this situation, we must ask for an increase in your natural gas rates. We want to tell you why this is necessary. The introduction of a new supply of Canadian gas means:

1st—Expenditures of many millions of dollars for new facilities, and

2nd—Sharply increased annual costs because of the higher price of this gas.

Millions of Dollars to Serve You

"Our contract to take Canadian gas from Alberta & Southern Gas Co. requires us to pay a much higher price than we have paid for any gas heretofore purchased. Purchase of A & S gas means . . .

$2,500,000 IN ADDED COSTS PER YEAR!

"We must build 60 mi of gas transmission line to bring A & S gas into our system. We have developed and are developing storage reservoirs to store gas in the summer when your use is at a minimum so that it will be instantly available when you need it on the coldest days of winter. Construction of the line and development of storage facilities will, by late 1961, have cost us in excess of . . .

$6,000,000 TO BRING YOU CANADIAN GAS!

"This is just part of a tremendous program of construction and plant additions we have been carrying on to assure you the best possible service. Since 1953, we have been constantly adding new facilities to serve you. In fact, we have spent on gas plant . . .

$34,900,000 IN THE LAST 7 YEARS!

"And our responsibility to you will require us to continue this program of growth and expansion in the future. Our construction forecasts indicate that we must spend for gas facilities a minimum of . . .

$16,800,000 IN THE NEXT 5 YEARS!

"In addition to the added cost of new gas, our day-to-day expenses continue to rise.

"In fact, our overall natural gas operating expenses have doubled in the last seven years! AND TAXES ARE UP 120% SINCE 1953. Today, taxes on our natural gas operations take 26c out of every dollar of gas revenue.

Canadian Gas Urgently Needed

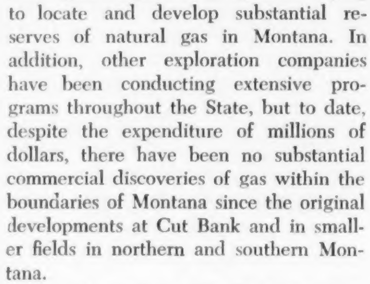
"Despite increased costs, however, we must obtain gas wherever we can get it. This is essential to your future service.

"Since 1931, we have been carrying on at great expense a program of trying to locate and develop substantial reserves of natural gas in Montana. In addition, other exploration companies have been conducting extensive programs throughout the State, but to date, despite the expenditure of millions of dollars, there have been no substantial commercial discoveries of gas within the boundaries of Montana since the original developments at Cut Bank and in smaller fields in northern and southern Montana.

"For this reason, we have had to turn to Canada which has enormous reserves of gas. In doing so, we are providing for your future requirements at the lowest possible cost.

"The importance of this new supply of Canadian gas may be demonstrated by the following fact:

"WITHOUT A & S gas and WITHOUT adequate storage, we could NOT supply the annual requirements of all our customers beginning with the winter of 1962-63.

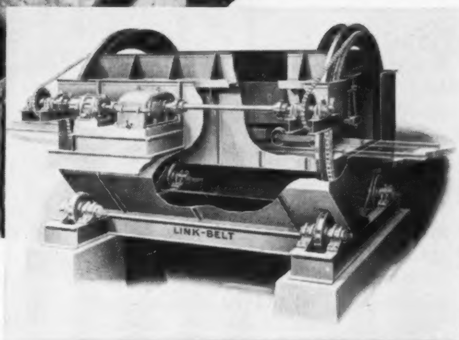


"The above chart demonstrates that, even with the proposed rate increase,

In This Section

Speed up your raw coal unloading

...with Link-Belt mine car hauls and dumpers



Mine cars are individually weighed before being moved into the Link-Belt dumper, where they are dumped two at a time without being uncoupled. (Positive-drive dumper shown at right.) ...

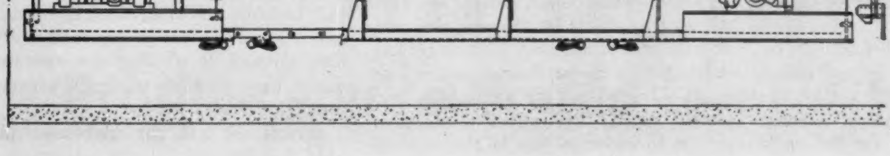


Diagram of typical mine car haul installation shows operation of chain, pushers and guiding members.

Fast and powerful, yet smooth and gentle—Link-Belt's rugged mine car hauls and car dumpers ride out the shocks of frequent start-stop operation. Dumpers hold cars securely, rotate 360° for thorough unloading and realign accurately in their original position.

Mine cars of all types and sizes are handled easily without damage. Unloading is accomplished at a fast rate without uncoupling. Both friction and chain-driven types accommodate either 4- or 8-wheel cars.

Modern mining operations include Link-Belt car hauls and dumpers in complete unloading systems or as individual components to match requirements. Contact your nearby Link-Belt office. Ask for a copy of Book 2655 describing a complete line of coal handling and preparation equipment.

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the cost of natural gas service is substantially lower than it is in other sections of the Pacific Northwest which now are getting Canadian gas. Natural gas rates for domestic customers in Washington, Oregon and Idaho are from 57% to 72% higher than they will be in Montana, based on the rates which we are proposing.

"The same situation exists when you compare the next most popular fuels available in Montana with natural gas. The comfort, convenience and economy of natural gas still make it the No. 1 heating fuel for your home.

"With oil, propane or coal, you don't get the efficient, courteous, complete service and trouble-free delivery that your Montana Power serviceman provides, day in and day out.

"Let's consider your situation as a homeowner. Even with our proposed new rates, if you own a typical five-room house with two bedrooms . . .

"IT WOULD COST YOU FROM $75.55 TO $98.52 MORE PER YEAR TO HEAT THAT HOUSE WITH OIL THAN WITH NATURAL GAS, DEPENDING ON WHERE YOU LIVE . . .

"OR, IF YOU USED PROPANE, YOUR ANNUAL FUEL BILL WOULD BE AS MUCH AS $234.72 MORE THAN IT WOLD BE IF YOU USED NATURAL GAS.

"In most areas on our system, coal is more expensive than natural gas and, as some of you remember, coal can't begin to match the cleanliness and convenience of natural gas.

"We sincerely regret that circumstances have forced us to ask you to pay more for your natural gas service.

"But we ask you to remember that natural gas is still your cheapest, most comfortable, most convenient fuel!

"If you have further questions about your natural gas service, contact your Montana Power representative who will be glad to discuss the rate situation with you. Meanwhile, we're standing by with all the natural gas you need."

Senate Committee To Study Nation's Fuel & Energy Needs

The Senate Interior Committee held hearings last month on a resolution (S. 105) which could eventually result in establishment of the much-discussed national fuels policy.

This resolution would establish a special Senate committee to study the nation's fuels and energy resources requirements. Proponents, including several senators, and coal industry spokesmen attended the June 12 hearings. On the following day, oil and gas witnesses were heard.

Interior Secretary Stewart L. Udall urged the Senate to authorize the study so that the country may never face an "energy gap." In prepared testimony, he stressed that U. S. energy requirements could double by 1975 and double again by the turn of the century. "This administration fully supports such a Senate study . . . We cannot let policy affecting resources as important as fuels and energy be set by drift, default, or by piecemeal actions which do not reflect such paramount considerations as the future health of our economy, national security and our concern for the well-being of the free world."

Coal for Factual Study

Three coal spokesmen also advocated adoption of the resolution in separate prepared statements.

George H. Love, chairman, National Coal Policy Conference, Inc., pointed out that the resolution has the support of all domestic fuels producers. Russia, he noted, and the other European nations have adopted fuels policies fashioned in their own national interests—only the United States has not. Mr. Love said the coal industry believes "every consumer should have a free choice of the fuel he desired to use so long as all fuels are permitted to compete on a fair and equitable basis. But today there are certain markets from which coal has been excluded by unfair and inequitable practices endorsed by various government agencies." However he said, "We do not come before you seeking special consideration for coal. We do ask that you approve a thorough and careful study of all aspects of our nation's fuels and energy problems . . . and we hope that such a policy will result in adoption of a sound national fuels policy . . ."

Joseph E. Moody, president, National Coal Policy Conference, Inc., said that for more than 20 yr responsible quarters have voiced adequate warnings "that the security of our fuels supplies was threatened, and sound planning for the future was essential." But until recently, these warnings "seemed to fall on the unheeding ears of Congress, the executive branch and the public." He warned of the adverse effects on domestic coal and oil industries of excessive oil imports and elaborated on recent Russian moves into world oil markets. In concluding, Mr. Moody stated, "My principal objective . . . is to convince you of the urgency with which we in the coal and related industries view the need for a thorough national fuels and energy study . . ."

Philip Sporn, president, American Electric Power Co., noted that "our high level of industrial production and productivity and our high level of economic welfare are based on the advanced development of our industrial plant and the large uses of mechanical energy to drive it." Based on an intensive study of our energy requirements for the next 40 yr, Mr. Sporn predicted for 1975 a 60% increase in total energy use above the 1960 level, of which 95% would continue to be provided by coal, oil and gas. For the year 2000, he projected an increase in total energy demand of 2⅓ times the 1960 use. This would mean "a requirement for petroleum of more than twice the 1960 level and that bituminous coal will have to supply almost double the 631 million tons maximum annual production ever achieved by the coal industry . . .

"It is essential," Mr. Sporn continued, "that we develop a sound national fuels policy based on a full and careful study of the Nation's energy resources base, the long-term expansion of the demands to be placed on these resources and the existing energy resources policies that may be in conflict with each other and with the best long-term interests of the country in assuring an adequate and economical supply of energy."

Oil and Gas Stress Fears Of End-Use Controls

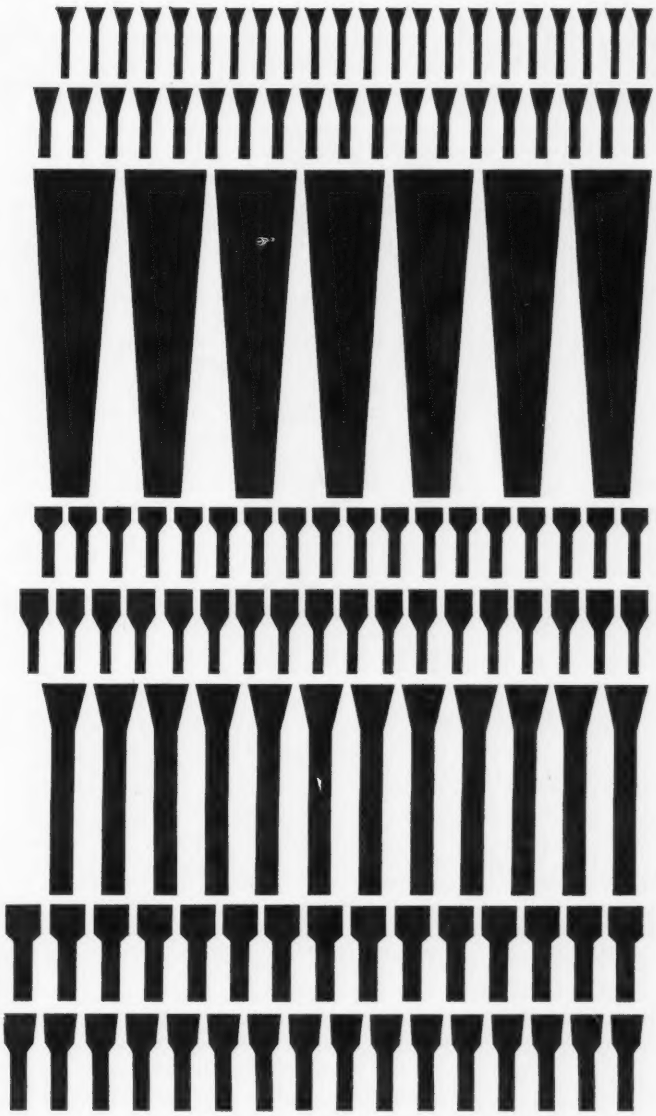
Oil and gas representatives professed to fear that "end-use" controls would result from the proposed national fuels study. They contended that the U. S. has substantial reserves of both oil and gas and therefore no conservation emergency exists. The real issue in any fuels study, they claimed, is whether the consumer should have freedom of choice between competing fuels.

Several oil and gas spokesmen implied that the coal industry was covering up its desire for market controls by a sweet-sounding request for an objective study of the nation's energy resources.

FPC Backs Bill to Curb Gas Inflation

The Federal Power Commission has endorsed a bill to keep natural gas producers and pipelines from pyramiding rate increases without FPC approval. In effect, this bill would block any new rate increases until the commission approves them. Under present law proposed rates take effect automatically after 5 mo, subject to refund if the FPC

(Continued on p 46)



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People in Coal

"Rags to Riches" Award to Peabody President

MERL C. KELCE, a former coal miner who worked his way up through the ranks to head the nation's second largest coal company, recently received the 1961 Horatio Alger Award.

The Peabody President was presented the bronze plaque by Brig. Gen. David Sarnoff (left), RCA chairman, in ceremonies May 17 at the Waldorf-Astoria Hotel, New York City.

The Horatio Alger novels of yesteryear inspired the name of this award, dedicated to the American free-enterprise tradition which holds that despite humble beginnings it is possible to achieve success through hard work, honesty and desire. In addition to Mr. Kelce, nine other prominent Americans including former President Eisenhower received the 1961 award.

Born in 1905 in Pittsburg, Kan., young Merl earned his first wages at the age of 7 picking strawberries and selling newspapers to help support his family after his father broke his back in a coal mine accident. When he was old enough to work in the mines, Merl found employment with the then small Sinclair Coal Co., founded by his late brother, Russell, and Grant Stauffer. Despite long hours of study at night for his high school diploma, Merl flashed such alertness as a miner that he was promoted to timekeeper when he was 18. From there, he became assistant foreman, superintendent of area mines, superintendent of all mines and ultimately vice president in charge of all Sinclair mining operations.

He was also responsible for the purchase of additional coal properties. And these acquisitions helped spur Sinclairs' growth to the point where it was able to merge with Peabody Coal in 1955. Merl became president of Peabody 2 yr later upon the death of his brother, Russell.

R. E. Salvati reached top rung on the ladder at Island Creek Coal Co. and its subsidiaries by his promotion from president to chairman and chief executive

Salvati

officer on June 7. **James L. Hamilton** also stepped up from executive vice president to president and chief administrative officer as well as vice chairman. Others elected to newly-created offices were: **F. A. Macdonald,** formerly general counsel, as vice president-law; and **F. C. Honchell** as vice president-finance. **B. E. Thornton** was elected controller, succeeding Mr. Honchell. All other Island Creek Co. officers were re-elected.

Mr. Salvati's birthplace is Monongah, W. Va., and his alma mater, West Virginia University. Upon his graduation from West Virginia in 1922, he began his career with Island Creek. In 1928 he was made manager of Pond Creek Pocahontas Co. then being managed by Island Creek officers and later merged with Island Creek. Appointed to general manager of Island Creek in 1936, Mr. Salvati became a vice president in 1940, a director in 1942 and president in 1949. In 1958, Mr. Salvati was chosen to receive the Horatio Alger Award and in 1959 was named "West Virginia Son of the Year." In 1960 the AIME selected him to receive the Erskine Ramsay Gold Medal Award.

In addition to his Island Creek appointment, Mr. Salvati has recently been named as one of the business advisers to the Gatt Conference in Geneva, Switzerland.

Island Creek's new president was born in Leeds, England, and with his parents moved to the U. S. in 1911. A Penn State graduate, Mr. Hamilton joined the Youngstown Sheet & Tube Co. in 1926 and served in various capacities. In 1934 he was appointed director of safety for Republic Steel Corp., assistant manager of coal mines in 1943 and manager of coal operations in 1945. His first post with Island Creek was vice president, operations, in 1949. He

Hamilton

was elected a director in 1955 and executive vice president the next year.

Samuel G. Lasky has been named assistant director of the Office of Coal Research, where he had been serving as acting director until George A. Lamb's recent appointment. Mr. Lasky has been an engineering consultant and advisor in the office of the assistant secretary of the Interior. A career employee of the Department for 30 yr, he is a nationally-known mining engineer, geologist and author.

Continued

Francis

At the 57th annual commencement of Davis & Elkins College (W. Va.) on June 5, an honorary Doctor of Laws degree was bestowed upon **David L. Francis.** In addition to his position as president of Princess Coals, Inc. and Mallory Stores, Inc. of Huntington, Mr. Francis is the mayor of Huntington, W. Va.

His higher education includes an A. B. degree from Yale in 1937 and an M. B. A. degree from Harvard in 1939. From 1942 to 1945, Mr. Francis served as a lieutenant commander with the U. S. Navy. Since 1945, numerous of his technical papers have appeared in *Coal Age.* And he has published many papers for the U. S. Chamber of Commerce and the National Association of Manufacturers.

He is, among other posts, a director of the National Coal Association, U. S. Chamber of Commerce, Southern States Industrial Council and Southern Coal Producers Association.

The coal industry's Old Timers' Club presented an engraved Mido watch to **John Patterson,** outstanding senior mining engineering student, Ohio State University, for his academic achievements. Planning on devoting his career to the industry, Mr. Patterson will be working for B. S. and M. S. degrees in mining engineering. He has been employed by the U. S. Steel Corp. and the mining divisions of Crucible Steel Corp. and Morton Salt Co.

New president of Wyoming's Natural Resource Board is **Glenn E. Sorensen.** Mr. Sorensen is president, Kemmerer Coal Co., as well as director, Wyoming Mining Association.

George Fumich Jr. of Morgantown, W. Va., has been made director, Office of Minerals Exploration, succeeding acting director **Frank E. Johnson** who will continue as deputy director. Mr. Fumich has been attorney and real estate manager for Christopher Coal Co. since 1949.

August J. Breitenstien has been designated a "Distinguished Alumnus" by the Ohio State University from which he graduated with a B. S. in mining engineering in 1926. Dean H. A. Bolz (left) made the presentation at the Annual Conference for Engineers. A well-known figure in the coal industry, Mr. Breitenstien is assistant vice president of raw materials, U.S. Steel Corp.

Thomas W. Howard, registered professional engineer, has announced organization of the firm, Thomas W. Howard, Inc. with offices at 323 Madison St., Mount Hope, W. Va. The new firm will provide varied engineering services to land and property owners and the coal industry. Mr. Howard was formerly chief engineer of the New River Co.

Associations

Big Sandy-Elkhorn Coal Operators Association elected as president, **C. T. Dahlin,** general manager, Princess Elkhorn Coal Div., Princess Coals, Inc. Other officials elected at the group's annual meeting were: First vice president, **B. F. Reed,** treasurer, Turner Elkhorn Mining Co.; second vice president, **George E. Evans Jr.,** president, Evans Elkhorn Coal Co., Inc.; treasurer, **L. B. Brashear,** president, Stephens Elkhorn Fuel Corp.; and administrative secretary, **Joseph H. Lyons.**

The Western Pennsylvania Coal Operators Association has elected the following officers: President, **G. O. Tarleton,** president, Pittsburgh Coal Co., Div. of Consolidation Coal Co.; vice president, **J. Allan Brookes,** manager, Mathier Collieries; executive vice president, **Harry A. Sutter;** treasurer, **M. C. Briggs;** secretary, **Earl Glass.**

Harvey Younker, vice president UMWA Dist. 2, was recently elected president of the newly-reactivated Pennsylvania State Bituminous Council of the **Holmes Safety Association.** Named first vice president was **Michael Vinoverski,** now deputy secretary of the Pennsylvania Department of Mines.

New officers of the **Utah Wyoming Coal Operators Association** include **Earl J. Evans,** vice president and controller, Royal and Spring Canyon Coal companies, president; **H. J. Schultz,** manager, Western Coal Mining Co., vice president. Re-elected to posts were **T. J. Canavan,** executive secretary-treasurer; **Mrs. Clara Outsen,** assistant secretary; and **D. A. James,** vice president, Liberty Fuel Co., assistant treasurer.

Dravo furnished ore handling and agglomeration facilities for this midwestern steel producer.

PLANT UTILITIES

When completed, this modern intake and pumping station will handle up to 30 million gallons of water daily. Such Dravo turn-key projects include oxygen, power and boiler plants, compressor stations, special mine, utility and plant facilities. Check coupon for information.

SPACE HEATING

One of 60 Dravo space heaters which supply comfort heating in this large strip mill. Over 20,000 (1/4 to 3 million btu) are in use throughout industry for processing, manufacturing, warehousing and other structures. Check and mail coupon for details.

Dravo Corporation, 4755 Grand Avenue, Pittsburgh 25, Pa.

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- ☐ Ore Bridges
- ☐ Sinter Plants & Coolers
- ☐ Grating
- ☐ Space Heaters
- ☐ Water Intakes
- ☐ Fabricated Piping
- ☐ Towboats, Barges
- ☐ Lubrication Systems

Name ____________ Title ____________

Company ____________

Address ____________

City ____________ Zone ____ State ____

DRAVO

Current Coal Patents

Oliver S. North
Patent Research and Abstracting
Washington, D. C.

Flexible strand sideframe conveyor and controlled flexible troughing idler assembly therefore, J. W. Hardy and R. F. Lo Presti (assigned to Goodman Mfg. Co., Chicago, Ill.), May 9, 1961. Improved connecting-securing means for positioning the troughing assemblies of flexible-strand sideframe conveyors relative to the flexible sideframe strand means thereof in order to control, in accordance with a given predetermined ratio, the flexible movement of both the troughing assembly and the strand means under varying load conditions so as to increase the troughing effect of the troughing assembly and to enable deflection of the strand means generally laterally outwardly relative to the conveyor course. No. 2,983,363.

Training linkage assembly for a belt conveyor, R. F. Lo Presti (assigned to Goodman Mfg. Co., Chicago, Ill.), May 9, 1961. Improved belt-training linkage means for supporting a troughing-idler assembly or a return-roller assembly, or both, of a conveyor in such a manner that misalignment of the conveyor belt transversely offcenter from the prescribed longitudinal course will act to turn or cant the entire troughing or return assembly, as a unit, in a substantially horizontal direction so as to train, drive or steer the conveyor belt back to a prescribed centrally-disposed longitudinal course. No. 2,983,364.

Supporting structure for flexible-strand sideframe conveyor, R. F. Lo Presti (assigned to Goodman Mfg. Co., Chicago, Ill.), May 9, 1961. Supporting structure for a flexible strand sideframe conveyor which positions the strand sideframes at a level that is immediately adjacent the primary support or the surface which underlies the conveyor, to enable the conveyor to be effectively separated by merely parting the belting without disturbing the supporting structure and flexible-strand sideframes so that machines and supplies can be easily transferred from one side of the conveyor to the other. No. 2,983,365.

Roof supports for mine workings, A. W. Duncan (Assigned to The Mining Engineering Co. Ltd., Worcester, England), May 23, 1961. Design for a mine roof support in which is incorporated reinforced-rubber tires filled with fluid under pressure and mounted with their axes vertical. The sidewalls of the tires are in contact with each other, whereby when the tires are under load their flexing will be limited to the treads. In very low seams, a support comprising a single tire may be adequate, but for seams of normal height a support will incorporate a number of superimposed tires. No. 2,985,419.

Mining apparatus, S. C. Moon (assigned to The Jeffrey Mfg. Co., a corporation of Ohio), May 30, 1961. Improved means for connecting a mining-machine discharge conveyor to an intermediate conveyor. This connection comprises pivot means loosely connecting the two conveyors, permitting the discharge conveyor to swing laterally relative to the intermediate conveyor, and the two to shift relatively to each other in accordance with the unevenness of the ground. No. 2,986,265.

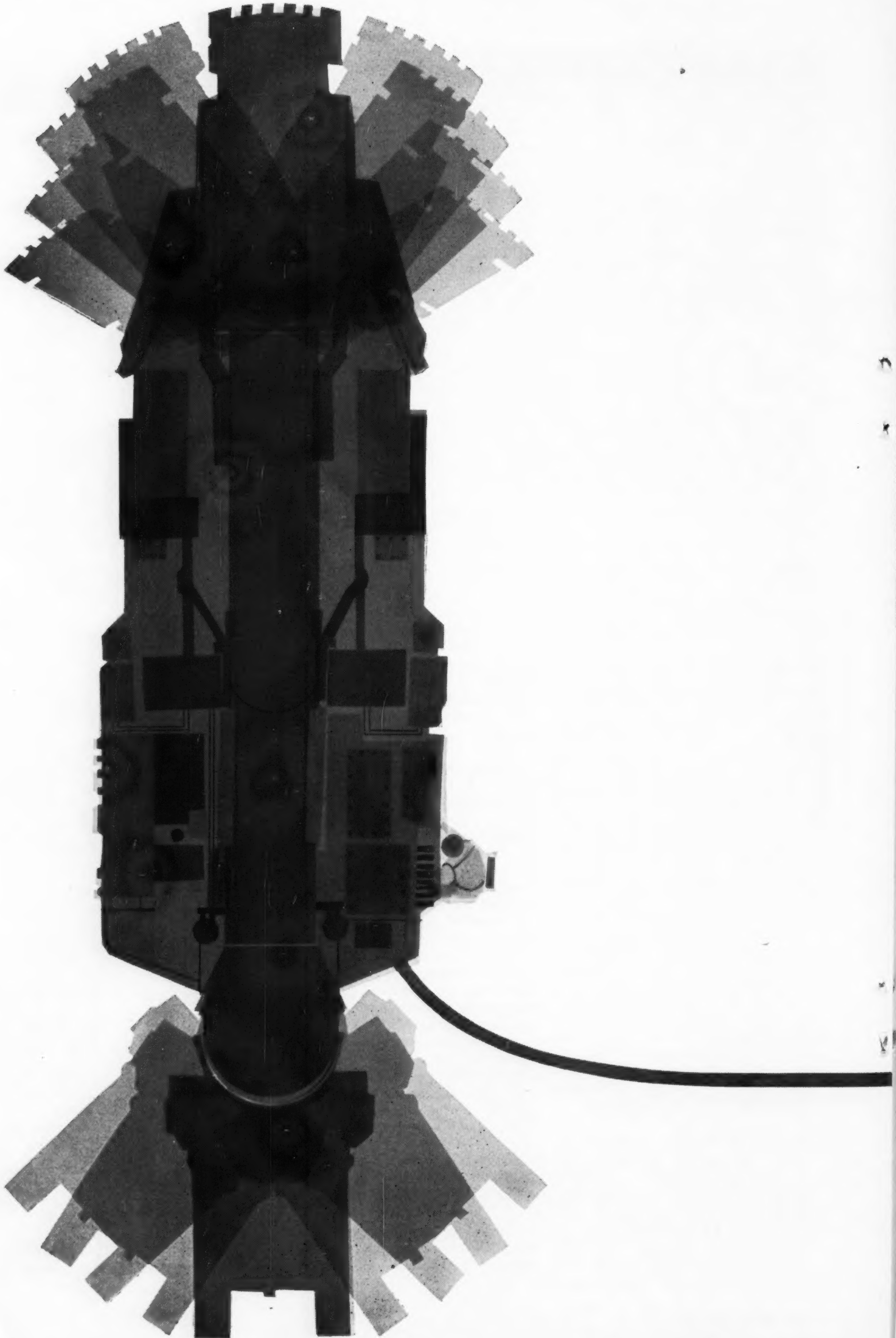
Endless belt conveyor, S. C. Moon (assigned to The Jeffrey Mfg. Co., a corporation of Ohio), May 30, 1961. In an endless belt-conveyor structure, the tail end includes a mobile unit with means for guiding and supporting the belt at the tail end. This mobile unit is formed compactly and with a relatively narrow width so as to facilitate maneuvering in the mine. The conveyor is extended by adding a length of belt and tramming the tail section in a direction away from the head section. No. 2,986,266.

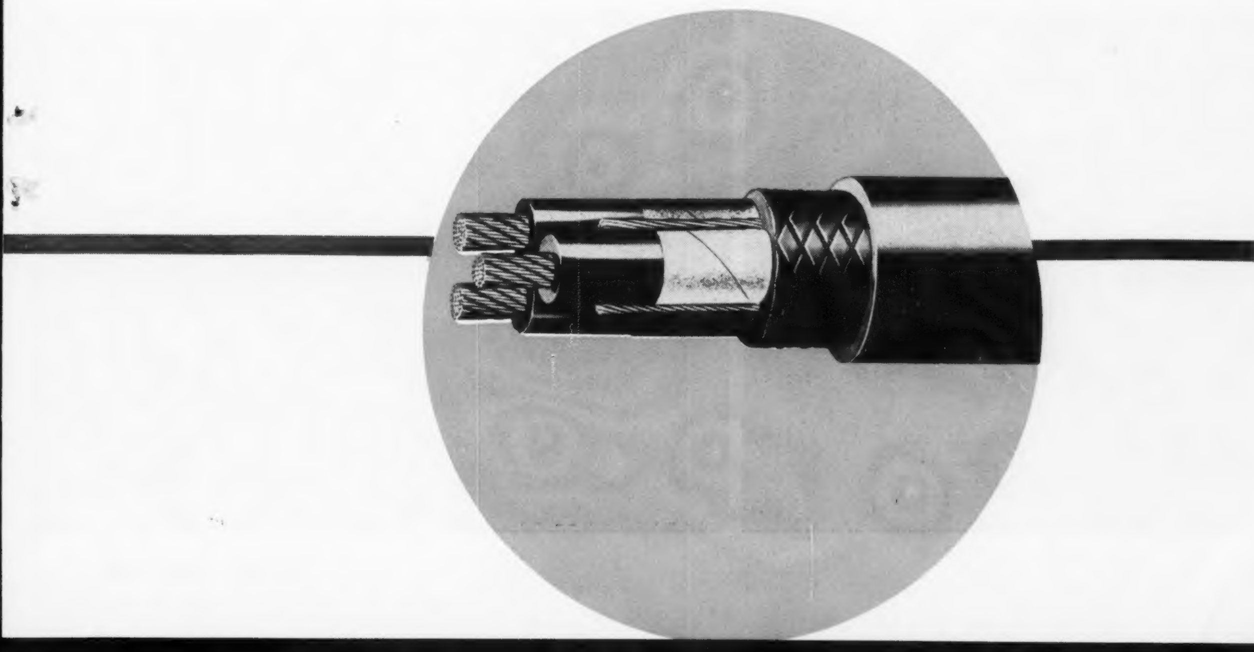
Explosive-containing bag used in blasting, J. F. Barco (assigned to Airmite-Midwest, Inc., Du Quoin, Ill.), Jan 3, 1961. In an improved method for utilizing ammonium nitrate in strip-mining blasting operations, the explosive composition is placed in a cylindrical laminated bag comprising an outer layer of fabric and an inner layer of Pilofilm, and having a captive pleat that is kept closed until the bag is dropped into the blasthole, at which time a ripcord is pulled to release the pleat and thereby enable the bag to expand as necessary to close the full cross-sectional area of the hole. No. 2,966,855.

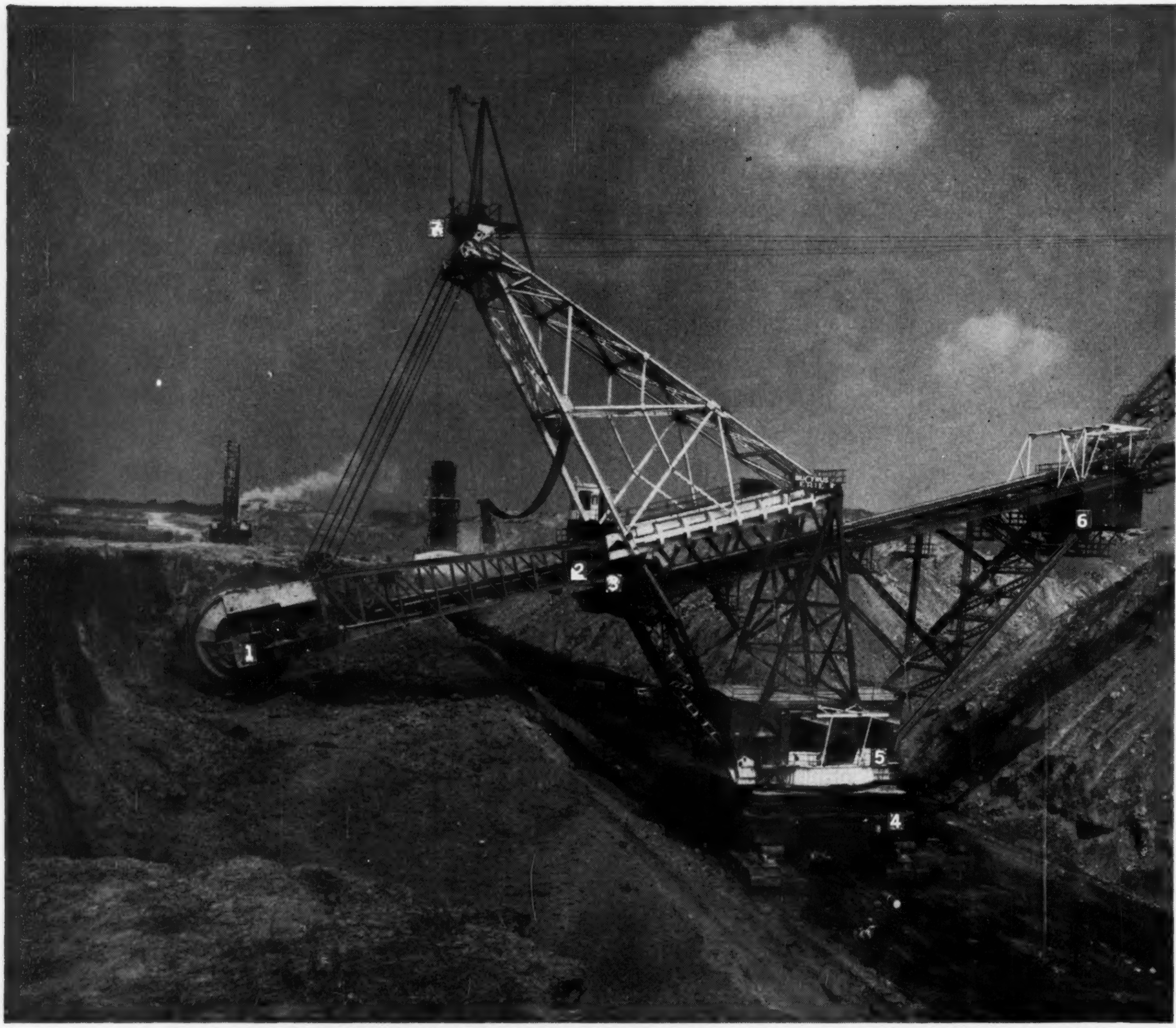
Portable conveyor apparatus, S. C. Moon (assigned to Jeffrey Mfg. Co., a corp. of Ohio), Jan. 3, 1961. Design for a conveyor apparatus which is adapted to follow a winding path from the point of loading to the point of discharge. The belt is supported and guided by means mounted on individual trucks connected with each other in a train. No. 2,966,984.

Tensioning means for trimmer chain of boring type miner, W. H. Mavity (assigned to Goodman Mfg. Co., Chi-

(*Continued on p 50*)

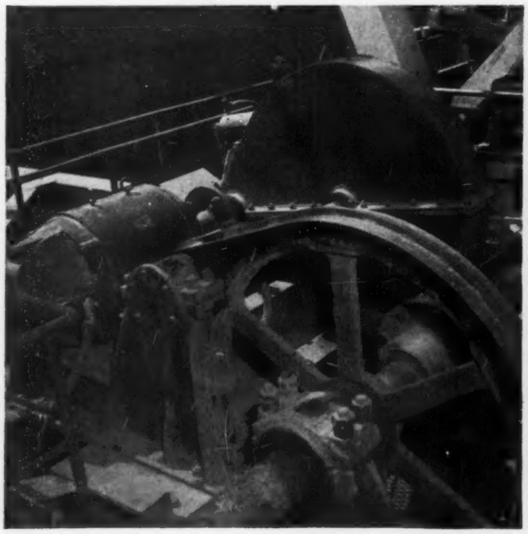




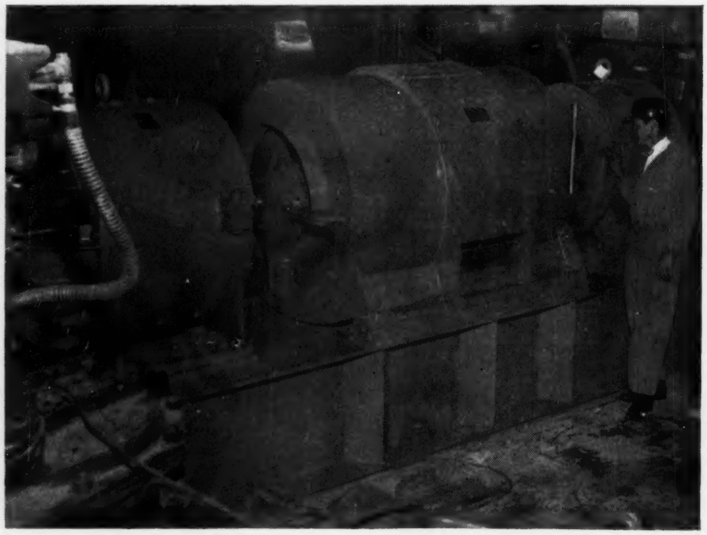


Wheel excavator removes top overburden at Peabody Coal's Freeburg, Ill., strip coal mine. Main drive elements are: 1. Wheel drive motor, 2. Crowd motor, 3. Digging ladder conveyor motor, 4. Propel motors, 5. Motor-generator sets, 6. Stacker conveyor motors, 7. Ladder hoist motor.

100 hp, a-c Westinghouse motor used for crowd motion.



One of two 1000 hp, 4 unit synchronous Westinghouse motor-generator sets with split frame generators and split bracket motor for full accessibility.



IN OPEN PIT OPERATIONS WESTINGHOUSE MOTORS AND WHEEL EXCAVATOR MAKE POWERFUL TEAM

As ratio of overburden thickness to coal seam thickness hits 20:1 or more (a 10:1 ratio was considered to be a break-even point only a few years ago), open pit operators continually search for new methods to remove overburden more economically.

An example of how one operator is tackling the problem is the Peabody Coal Company operation at its River King mine, Freeburg, Illinois. Peabody has teamed up a giant new wheel excavator with a large stripping shovel. The wheel excavator, manufactured by Bucyrus-Erie Company and exclusively powered by Westinghouse motors, removes the dirt and clay of the overburden. Behind the wheel excavator, the shovel scoops out the shale and hard rock to expose the coal seam.

Preliminary operations indicate that this "tandem" arrangement is much more efficient than a shovel working alone. But, an important part of the forecasted savings originates with the design and operation of the new wheel excavator itself.

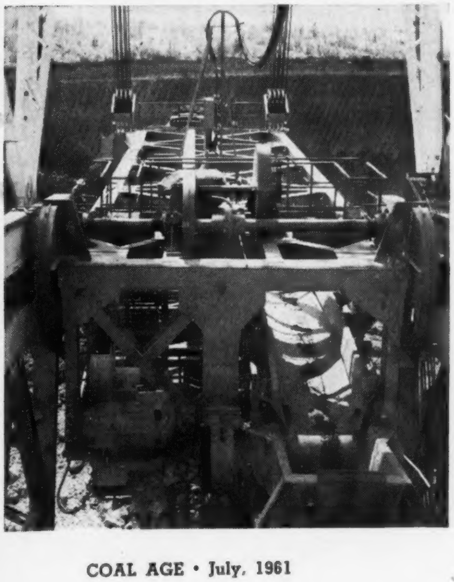
It is capable of moving 3000 cubic yards of dirt per hour and depositing it 400 feet from the digging wheel to the spoil bank. Its crowd motion is up to 45 feet and driven by a 100 hp Westinghouse Lifeline a-c wound rotor motor with a-c reversing starters. This particular motor is well suited to the severe reversing, plugging service and frequent stopping and starting. The motor's rugged frame and feet assure maximum strength and rigidity to shock, vibration and physical abuse. The ladder hoist range of the wheel excavator is 40 to 100 feet at 15° angle and the motion is powered by a 150-300 hp Westinghouse d-c motor. A 90 foot long ladder conveyor operates continuously at 945 fpm and is driven by a 187.5-375 hp Westinghouse d-c motor. The Stacker conveyor extends 327 feet, moves faster (1260 fpm) than ladder conveyor to avoid pile-up of dirt at transfer point. This stacker conveyor and wheel employs two 250-500 ph Westinghouse d-c motors.

Swing motion of the new machine is operated by two 25-50 hp Westinghouse d-c motors. Low inertia armatures, greater field coil capacity, more torque per ampere — all features of Westinghouse motors — are particularly advantageous for this motion by allowing acceleration, deceleration, start, stop and reverse with a minimum of time and power. Exclusive Westinghouse insulation systems give maximum life and protection; mechanical designs include easily accessible motor leads, split steel frame d-c shovel type motors, steel shell field coil construction, maximum diameter shafts through punchings and with no overhung commutators.

The 3,200,000 lb, 410 ft long, 180 ft high wheel excavator is propelled forward or reverse by four 100 hp, a-c Westinghouse motors, known throughout industry for reliability under tough operating conditions.

If you need information on how Westinghouse electrical equipment can help you realize greater operating efficiency at lower cost, see your Westinghouse sales engineer or write: Westinghouse Electric Corporation, Box 868, Pittsburgh 22, Pa. *You can be sure . . . if it's Westinghouse.*

187½ hp forced ventilated d-c digging ladder conveyor Westinghouse motor (center, left) and 100 hp, a-c Westinghouse crowd motor (rear).



Westinghouse

J-96174

Coal Abroad

Britain's Coal Board Fights Liquid Methane Imports

In a determined effort to dissuade the gas council from proceeding with plans to import liquid methane from the Sahara, Britain's National Coal Board has ordered an economics study of large-scale Lurgi plants.

Meanwhile the gas council, which reached agreement with Conch International Methane Ltd. and French authorities on terms of methane imports, has submitted the plan to Minister of Power Richard Wood. If the plan is approved, about 350 million therms (700,000 long tons) of liquid methane would be imported a year. This is equivalent to about 10 to 15% of present U. K. demand.

Overseas Flashes

WEST GERMANY—A survey, conducted by the Economic Research Institute covering the competitive situation between fuel oil and coal in Germany, showed that one-fifth of all industrial firms have switched completely to oil. Almost 50% of the companies questioned are very much in the market for eventually turning to heating fuel. This would mean that oil has chances to acquire 70% of industrial fuel consumption in a country in which, before World War II, even gasoline was produced greatly from coal.

GREAT BRITAIN — Britain's National Coal Board had a deficit of $59.64 million in 1960, the ninth year the board had lost money since its inception in 1947. But the board expects to be out of the red by the end of next year, Chairman Alfred Robens said. This would not be done by raising prices, already under pressure of oil competition, he stressed, but by improved productivity, increased economies, new techniques and sustained demand for coal.

Asked about recent moves to import American coal for steelmaking (*Coal Age*, June, 1961, p 33), Robens said that if imports ever became necessary, the board should make a "very vigorous claim" to be the sole importers.

AUSTRALIA—An offshore loading terminal is planned 35 mi south of Sydney to speed shipment of coal to Japan. It would enable Japan's 45,000-ton colliers to load in two days — or the same time presently required to load a 10,000-ton vessel with existing facilities. Australian coal men expect that the new loader will make Australian coal more competitive in price with North American hard-coking coal on the Japanese market.

Bituminous Output

YEAR TO DATE	PRODUCTION
June 10, 1961	166,678,000
June 11, 1960	195,992,000

1961 output 15.0% behind 1960.

WEEK ENDING	PRODUCTION
June 10, 1961	8,470,000
June 11, 1960	8,738,000

Anthracite Output

YEAR TO DATE	PRODUCTION
June 10, 1961	8,178,000
June 11, 1960	8,274,000

1961 output 1.2% behind 1960.

WEEK ENDING	PRODUCTION
June 10, 1961	353,000
June 11, 1960	369,000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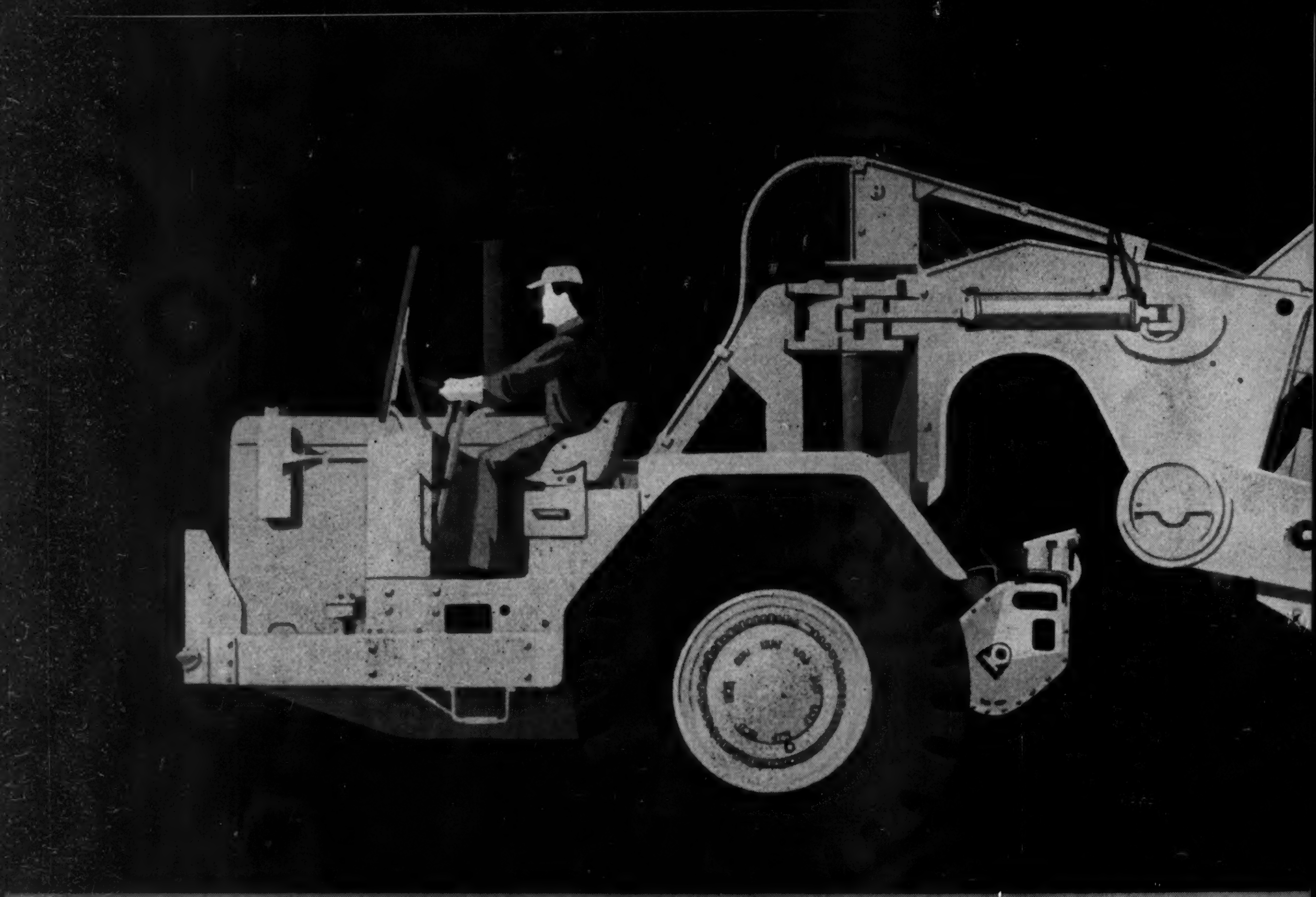
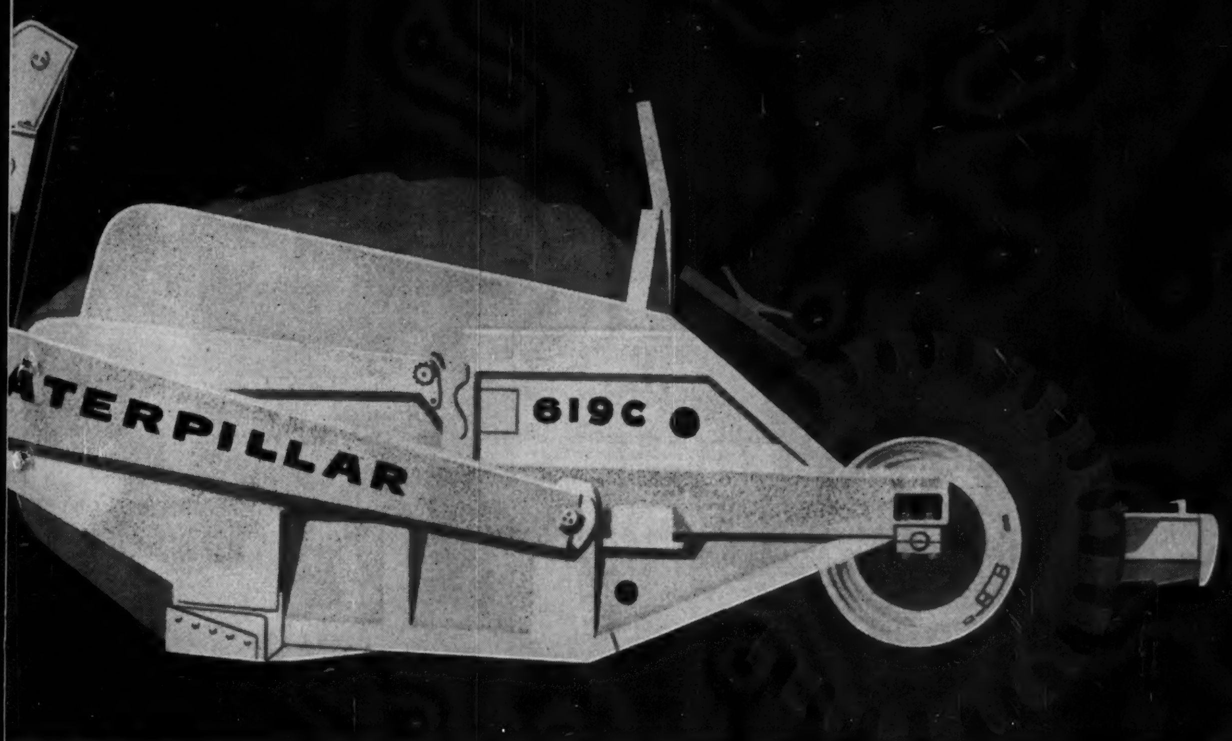
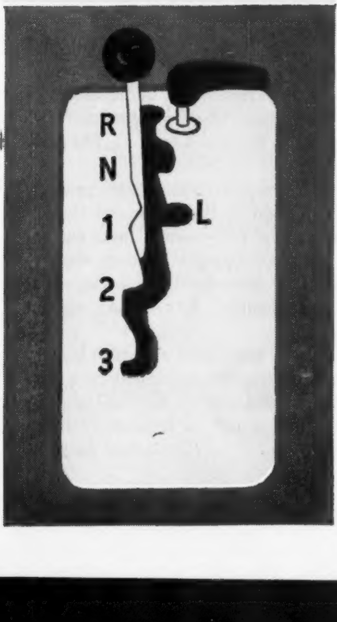


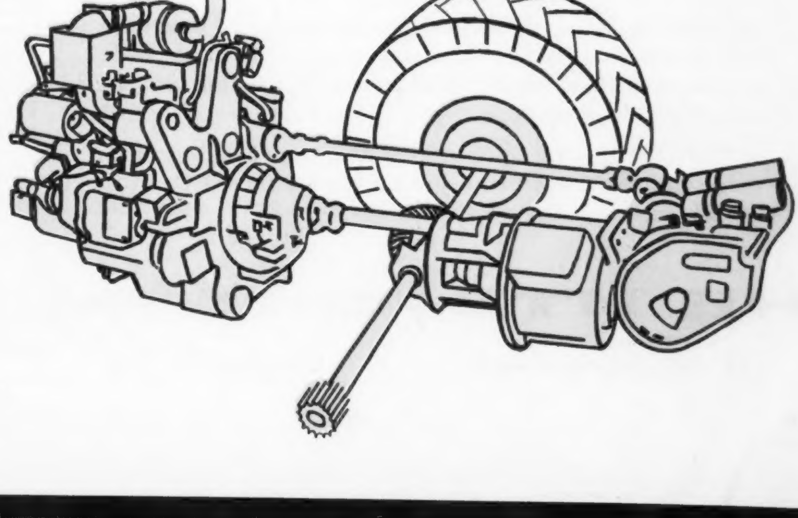




New 280 HP 619C offers choice of power shift transmission for faster, easier operation or direct drive transmission. Air actuated, live power cable control reduces operator effort. New, bigger 26.5 x 29 (22 ply) tires improve roadability. Top speed: 30 MPH. Capacity of matching Lowbowl scraper: 18 cu. yd. heaped, 14 cu. yd. struck. Also available: 25 ton PR619 Rear Dump Trailer built by Athey Products Corp.

New power shift transmission provides 9 speeds forward with just 3 shifts. One lever gives operator instant selection of 3 speed ranges . . . dial indicator tells him **when** to shift. Within each speed range, transmission **automatically** shifts to torque divider drive, direct drive or overdrive to match job conditions. The 619C with power shift transmission always operates at the right speed and power for the job at hand.

New, more powerful Cat D340 Engine (280 HP maximum, 250 HP flywheel at 1900 RPM). This economical 4-cylinder engine burns No. 2 fuel oil . . . has parallel-ported dual intake and exhaust valves and overhead camshafts for most efficient operation . . . has pressure ratio controlled turbocharger and aftercooler. Swingaway dash and pivoted crankcase guard simplify servicing. Unit construction assures easy servicing: engine, transmission, planetary final drives can be removed without disturbing adjacent components.



(Continued from p 28)

does not act on them. The FPC, however, may judge it necessary to allow new rate increases pending a final ruling.

Gas companies now have a "virtually unlimited right" to raise gas prices still further while the commission is considering earlier rate applications, FPC Chairman Jerome Kuykendall told the Senate Commerce Committee.

The bill, drawn by the National Association of Railroad & Utilities Commissioners, would also allow FPC to suspend rate changes involving sale of natural gas to be resold for industrial use.

Pier Equipment Contract

Mechanical equipment for the world's largest and fastest coal pier (*Coal Age*, January, 1961, p 26) is being designed by Wellman Engineering Co. of the McDowell-Wellman Cos., Cleveland. The Wellman contract includes twin high-speed rotary cardumpers, more than a mile of 8-ft-wide conveyor belts and a mammoth 10,000-tph shiploader.

Owner of the \$19,000,000 dock, the Norfolk & Western Railway, has already begun pier construction. Planned to receive the largest ships now afloat or on drawing boards, this pier will handle various grades of export coal from mines served by the N&W system.

A standing-room-only crowd attended a Technical Mining Session Program presented by Ohio State University's Mining Engineering Div. "Pioneering Mining Developments in Ohio" was the theme of this part of the Annual Conference for Engineers attended by over 800 engineers.

The papers presented featured Ohio mining and its challenges especially in strip coal mining in which Ohio is the largest in the nation. First on the program, presided over by Prof. J. Richard Lucas, Mining Engineering Div., was S. G. Hughes, president, Differential Steel Car Co. Mr. Hughes spoke on the coal industry's Old Timers Club and made the annual watch award to the most outstanding mining engineering student (see p32). W. A. Weimer, chief mining engineer, Peabody Coal Corp., discussed the operating and engineering problems of "Automatic Mining" at Coshocton County coal properties. Andrew Hyslop, chief engineer, Hanna Coal Co., gave his paper entitled "Engineering and Operating Study of High-Capacity Stripping Shovels."

Program Begun to Develop Natural Gas Fuel Cell

A joint program to develop a natural gas fuel cell has been undertaken by Northern Natural Gas Co., Omaha, Neb., and Houdry Process Corp. of Philadelphia.

These firms will attempt to produce electricity right in the home and factory by using a fuel cell powered with natural gas which will supply all energy requirements of a household or business at costs significantly less than current sources.

A fuel cell resembles a storage battery which is continually recharged by a supply of fuel and air. As the fuel and air are fed into a cell, a catalyst performs

(Continued on p 54)

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CORPORATION

300 Park Avenue, New York 22, N. Y.

cago, Ill.), May 16, 1961. A simplified and improved hydraulically-actuated mechanism is provided for maintaining a uniform degree of tension on the trimmer chain of a boring machine, adjustable to cut coal in seams of varying thicknesses. A step-up drive connection between the hydraulic power means and tensioning idler takes up tension on the chain. The tensioning means may be made so compactly that it can be entirely mounted on the cutter frame of the machine. No. 2,984,469.

Conveyor structure for continuous miner, R. H. Kraft (assigned to Goodman Mfg. Co., Chicago, Ill.), May 16, 1961. Improved conveyor structure for continuous mining machines of the boring type having a lower adjustable trimmer bar for cutting along the mine floor. The conveyor structure is so arranged as to accommodate free adjustment of the machine for various cutting heights, without interfering with the receiving end of the conveyor to be positioned in closer relation to the working faces than formerly. No. 2,984,470.

Hydraulic-actuated apparatus for controlling slack in conveyor belts, M. G. Carlson and J. J. Delaney (assigned to Goodman Mfg. Co., Chicago, Ill.), May 30, 1961. Hydraulic tensioning and belt slack take-up system in which a main pump supplies pressure to a reciprocable belt take-up roller which puts tension in the belt during normal operation, the main pump being supplemented by an auxiliary pump that cuts in automatically in response to a drop in pressure in the system during start up. Sliding friction, which can start mine fires, is reduced or eliminated. No. 2,986,267.

Mining machine having tiltable dual mining head, N. W. Densmore (assigned to Joy Mfg. Co., Pittsburgh, Pa.), May 30, 1961. This improved multiple-head-type coal-mining machine for use in low seams is extremely vertically compact while retaining the desired lateral flexibility and adjustability. The machine is reversible, and embodies reversible cutting and dislodging mechanism. No. 2,986,384.

Mining machine having a plurality of dislodging rotors, N. W. Densmore (assigned to Joy Mfg. Co., Pittsburgh, Pa.), May 30, 1961. Design for a coal-mining machine which is provided with an improved multiple-head cutting and dislodging mechanism which can be adjusted for varying seam thicknesses. No. 2,986,385.

Improved self-cleaning magnetic separator, J. J. Ferris and J. L. Hope (assigned to Magnetic Engineering & Mfg. Co., Clifton, N. J.), June 6, 1961.

Any way you look at Roebling Royal Blue Wire Rope, there's real savings in it for you. In its inner and outer uniformity. In its *extra*-high strength. In unison, these qualities provide unrivalled resistance to abrasion, impact, crushing and tough sheave pressures. Royal Blue—inside and outside—goes on paying off for you when lesser wire rope would need replacing. Find out more from your wire rope distributor, or write for free booklet to Roebling's Wire Rope Division, Trenton 2, New Jersey.

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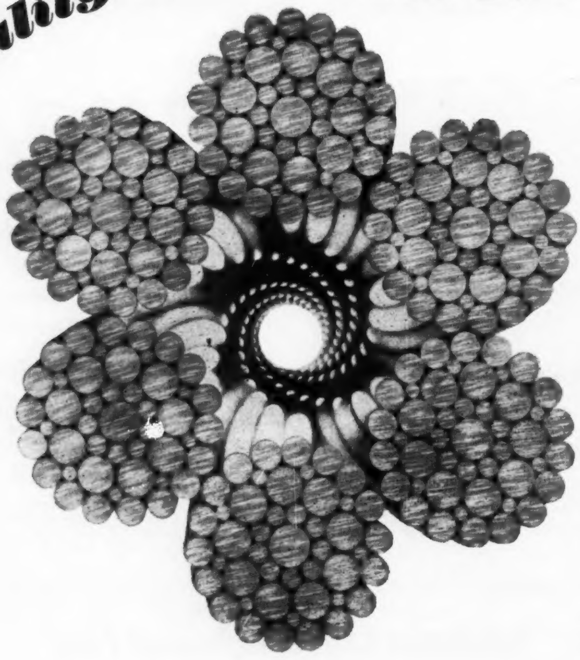
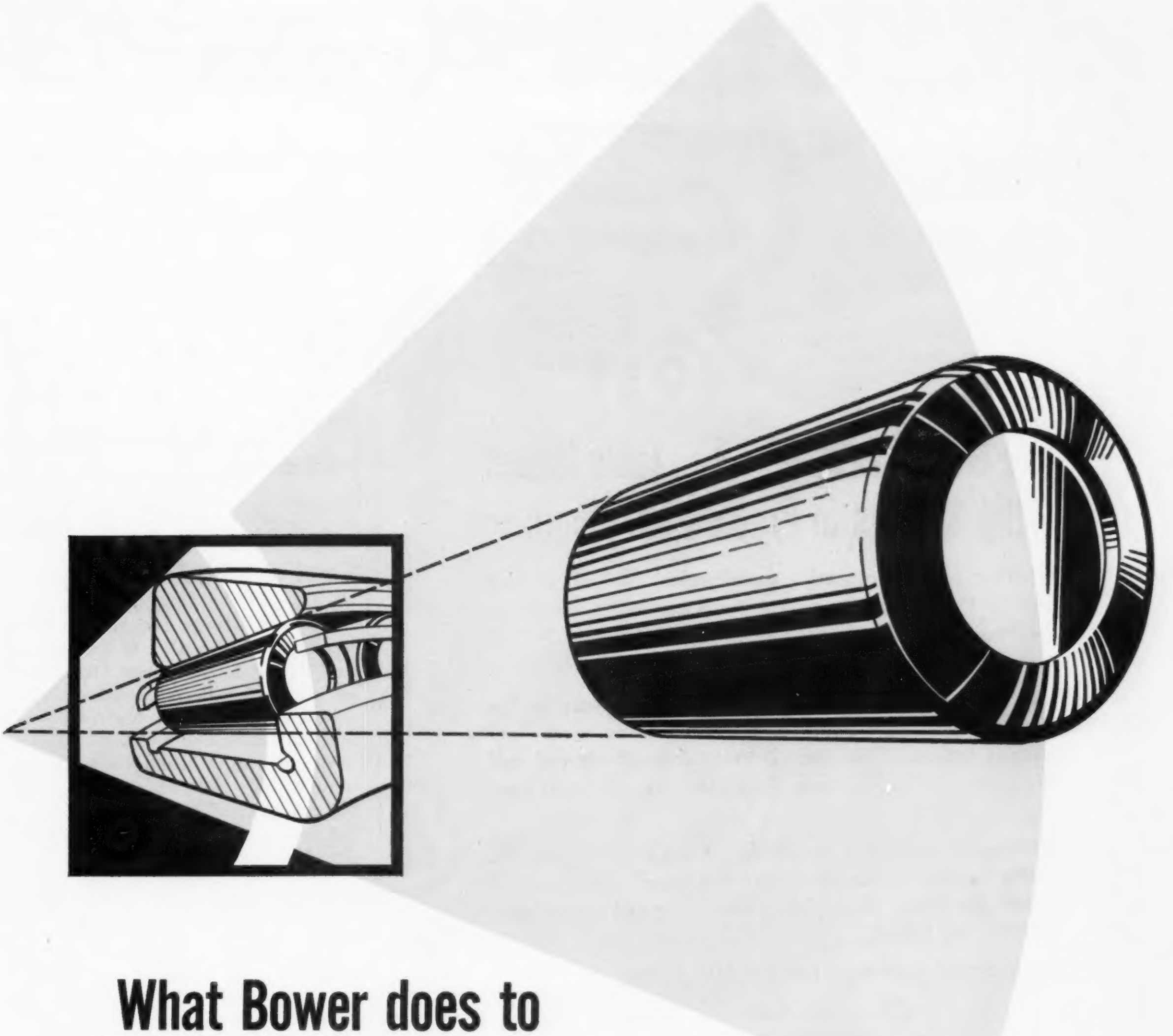


We put a lot of work into it —
You get a lot of work out of it



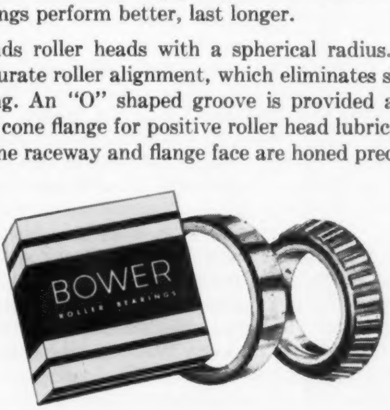
What Bower does to roller heads to give tapered bearings longer life

The spherical head design shown above is part of what we call "Spher-O-Hone". It simply means that Bower tapered roller bearings perform better, last longer.

Bower grinds roller heads with a spherical radius. This assures accurate roller alignment, which eliminates sliding and skewing. An "O" shaped groove is provided at the base of the cone flange for positive roller head lubrication. And the cone raceway and flange face are honed precisely. These further lessen friction, thus reducing wear.

This is typical of the attention paid to details in design and manufacture by Bower engineers. And to you this attention can mean faster schedules, less downtime and greater profit from each job because Bower bearings handle maximum capacity loads and last longer.

When you need tapered or straight roller bearings of any type or size, be sure to specify Bower.



BOWER ROLLER BEARINGS

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DIVISION OF FEDERAL-MOGUL-BOWER BEARINGS, INC. • DETROIT 13, MICH.

a marriage of the elements, directly producing electricity without the complex equipment needed under the standard system.

P&M Buys 90-Yd Shovel

Pittsburg & Midway Coal Mining Co. has purchased a huge 90-cu yd excavator from Bucyrus-Erie Co.

This machine's electric power plant, totaling 9,000 hp, will enable it to take 150-ton bites of overburden, swing and deposit it more than 300 ft away in less than 1 min. When fully erected, the Model 1850-B will weigh over 8,000,000 lb and stand higher than a 15-story building. It is scheduled for delivery next year.

Coal Transfer Facility To Start Operations

New rail-to-barge coal transfer facilities at Florence, Ala., to handle coal destined for TVA's Colbert Steam plant are scheduled to begin operation July 11, when the Louisville & Nashville R. R. will start delivering trainloads of coal.

This modern pushbutton unloading facility, capable of handling up to 3,000,000 tons of coal a year, will have the first remote-controlled locomotive to be placed in service in the South.

The announcement was made by O. B. Keister Jr., president of Transportation Services, Inc. which designs and sells automated facilities for rapid unloading of coal at rail-to-barge terminals and at steam-generating plants. Mr. Keister, who had been assistant to the president of L&N, resigned last February to head his own company.

Mines, Companies

A new coal mine which will have an annual capacity of 1,200,000 tons and provide employment for some 400 persons will be developed jointly by Republic Steel Corp. and Island Creek Coal Co.

These firms will form a new corporation to be known as the Beatrice Pocahontas Co. A high-quality, low-ash, low-sulfur, Pocahontas No. 3 seam metallurgical coal will be produced by the new mine to be located in Buchanan County, near Grundy, Va. This coal will be used by Republic at its steel plants in Ohio, Illinois and New York.

Island Creek Coal has also announced plans to reopen on July 10 the company's Mine No. 22 at Pine Creek, Logan County, W. Va. Initial daily production will be 1,000 tons, permitting the recall of upward to 70 men.

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with complete engineering,

MORGANTOWN

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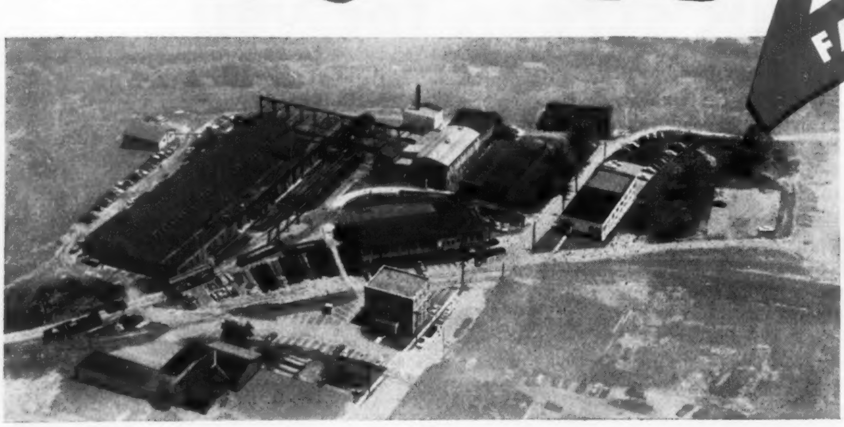
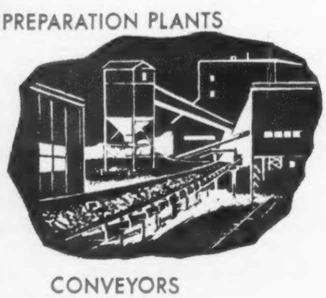


PREPARATION PLANTS



CONVEYORS

Utilization

Nearly 5,000 tons of coal a day will be consumed by two 320,000-kw generating units at the new Mercer generating station on the Delaware River in Hamilton Township, N. J. These units, the second of which has just been placed in commercial operation, are the largest in New Jersey, say Public Service Electric & Gas Co. officials.

The nation's first "care-free" home development — total electric indoors and colorama aluminum siding outdoors — is rising in the history-rich, lake-spotted Ramapo Mountains in northern New Jersey. On a 1,000-acre site 700 ft above sea level, Continental Forge Homes is developing plots for middle income families.

Electric heating cable, imbedded in the plaster of the ceiling, provides draft-free radiant heat indoors with each room thermostatically controlled. In addition there is extensive wiring for full housepower requirements, planned lighting and a complete automatic kitchen. General Electric Co. is providing the all-electric appliances.

Preparation Facilities

Clinchfield Coal Co., Moss No. 3, Clinchfield, Va. — Contract closed with Peterson Filters & Engrg. Co. for one "Dual Guide" disc filter, 12 ft 6 in dia by 14 discs containing 3,080 sq ft filter area to filter 60-70 tph of forth-flotation tailings. Link-Belt Co. is prime contractor.

Bethlehem Mines Corp., Barrackville, W. Va.—Contract closed with Peterson Filters & Engrg. Co. for one "Dual Guide" disc filter, 8 ft 10 in dia by four discs to filter 12-15 tph of clean coal from froth flotation. Prime contractor is Roberts & Schaefer Co.

Stonega Coke & Coal Co., Glenbrook Mine, Glenbrook, Ky.—Contract closed with Peterson Filters & Engrg. Co. for the "Contour Scraper" disc filter, 8 ft 10 in dia by four discs to filter refuse thickener underflow. McNally Pittsburg Mfg. Corp. is the prime contractor.

Bell & Zoller Coal Co., Murdock Mine, Murdock, Ill.—Contract closed with Link-Belt Co. for a Fluid-Flo heat dryer and accessories to handle 1x0 or 3/8x0 coal at 90 tph.

Matway Coal Co., Bentleyville, Pa.—Purchase authority granted The Daniels Co., Contractors, Inc., covering installa-

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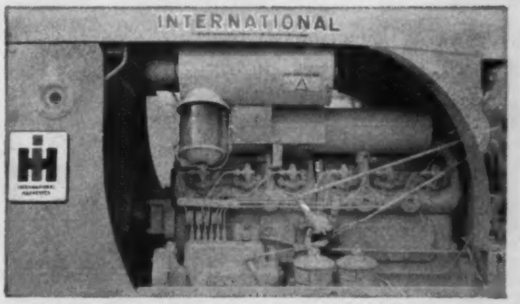

Look at the "15's" new dry-type air cleaner. It's 99.8% efficient — and 100% convenient! Handy, underhood mounting and transparent, quick-dump collector greatly simplify servicing. International even provides a dash indicator that shows red when element needs servicing!

Prove new "15's" undercarriage strength!

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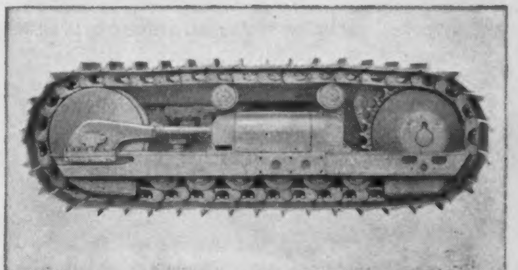

tion of a DMS dense-media precision coal-preparation system designed to prepare special coals from the company's mine on Pittsburgh No. 8 seam. Sizing and conditioning facilities with DMS dense-media washer, medium-reclamation apparatus, automatic volumetric control of specific gravity and grading and loading facilities are included.

Kocher Coal Co., Good Springs, Schuylkill County, Pa.—Contract closed with Deister Concentrator Co., Inc. for one SuperDuty Diagonal Deck No. 7 coal-washing table to clean No. 4 buck anthracite coal.

New River Co., Summerlee Mine, Summerlee, W. Va. — Contract closed with Deister Concentrator Co., Inc. for eight Concenco No. 77 twin-deck, Diagonal Deck coal-washing tables to handle ¼x0 coal.

Maiden Mining Co., Mine No. 4, Poland, Pa.—Contract closed with Ducon Co., Inc. for primary high-efficiency cyclones for Dorr Oliver's Fluosolids fine-coal thermal dryer.

Coming Meetings

International Briquetting Association Conference, Aug. 28-30, 1961—Jackson Lake Lodge, Jackson, Wyo.

National First-Aid and Mine-Rescue Contest, Oct. 2-4, 1961—Location changed due to uncertainty in construction schedule of Pittsburgh's new auditorium. New location will be new Civic Center, Charleston, W. Va.

West Virginia Coal Mining Institute, Central Appalachian Section, AIME, Nov. 3-4, 1951—Greenbrier Hotel, White Sulphur Springs, W. Va.

Coal Division Conference, American Mining Congres, Nov. 17, 1961—Penn-Sheraton Hotel, Pittsburgh, Pa. Coal Division Committee Meetings:

Aug. 9, Roof; Aug 10, Mechanical Mining; Aug. 11, Haulage; Daniel Boone Hotel, Charleston, W. Va.

Aug. 22, Coal Prep.; Aug. 23, Power; Brown Hotel, Louisville, Ky.

Aug. 25, Strip; McCurdy Hotel, Evansville, Ind.

Aug. 31, Safety; Sept. 1, Research; Sheraton Park, Washington, D. C.

Coal Mining Institute of America, 75th Annual Meeting, Dec. 14-15, 1961—Penn-Sheraton Hotel Pittsburgh, Pa.

Equipment Approvals

Joy Mfg. Co.—Type 12RB coal cutter; two motors, one 50-hp and one 30-hp, 250-V, DC. Approval 2F-1640, May 2.

Lee-Norse Co.—Type CM38Y-3K continuous miner; three motors, each 75-hp, 250-V, DC. Approval 2F-1641, May 3.

Wilcox Mfg. Co.—Model Mark 20-A continuous miner; four motors, two 50-hp, one 15-hp and one 7½-hp, 220- /440-V, AC. Approvals 2F-1642 and 2F-1642A, May 3.

Jeffrey Mfg. Co.—Type MM-56RDR-2 two-arm roof drill with integral dust collecting system; two motors, one 15-hp and one 2-hp, 250-V, DC. Approval 2F-1643, May 3.

Joy Mfg. Co.—Type 16RB coal cutter; two motors, one 50-hp and one 30-hp, 250-V, DC. Approval 2F-1644, May 8.

Ensign Electric & Mfg. Co.—Wheel-mounted distribution box; four-circuit, 250-V, DC. Approval 2F-1645, May 9.

Acme Machinery Co.—Model 325-RA4J drill jumbo; one motor, 90-hp, 440-V, AC. Approval 2F-1646A, May 10.

Acme Machinery Co.—Model 325-RA4-C rotary air compressor; one motor, 100-hp, 440-V, AC. Approval 2F-1647A, May 11.

National Mine Service Co.—Type 6WT-1 Torkar shuttle car; one motor, 33-hp, 250-V, DC. Approval 2F-1648, May 18.

Plymouth Locomotive Works, Fate-Root-Heath Co.—Model DMD-24, 10- to 15-ton locomotive powered by Caterpillar Tractor Co. Model D330A-T turbocharged diesel engine for use in noncoal mines. Approval 24-41, May 18.

Compton, Inc.—Model CU42X continuous miner; three motors, two 75-hp and one 100-hp, 440-V, AC. Approval 2F-1649A, May 23.

J. H. Fletcher & Co.—Hydraulic miner with integral roof drill and dust collecting system; one motor, 25-hp, 440-V, AC. Approval 2F-1650A, May 24.

Long-Airdox Co.—Model LRB-7 roof drill with integral dust collecting system; two motors, each 15-hp, 220- /440-V, AC. Approvals 2F-1651 and 2F-1651A, May 26.

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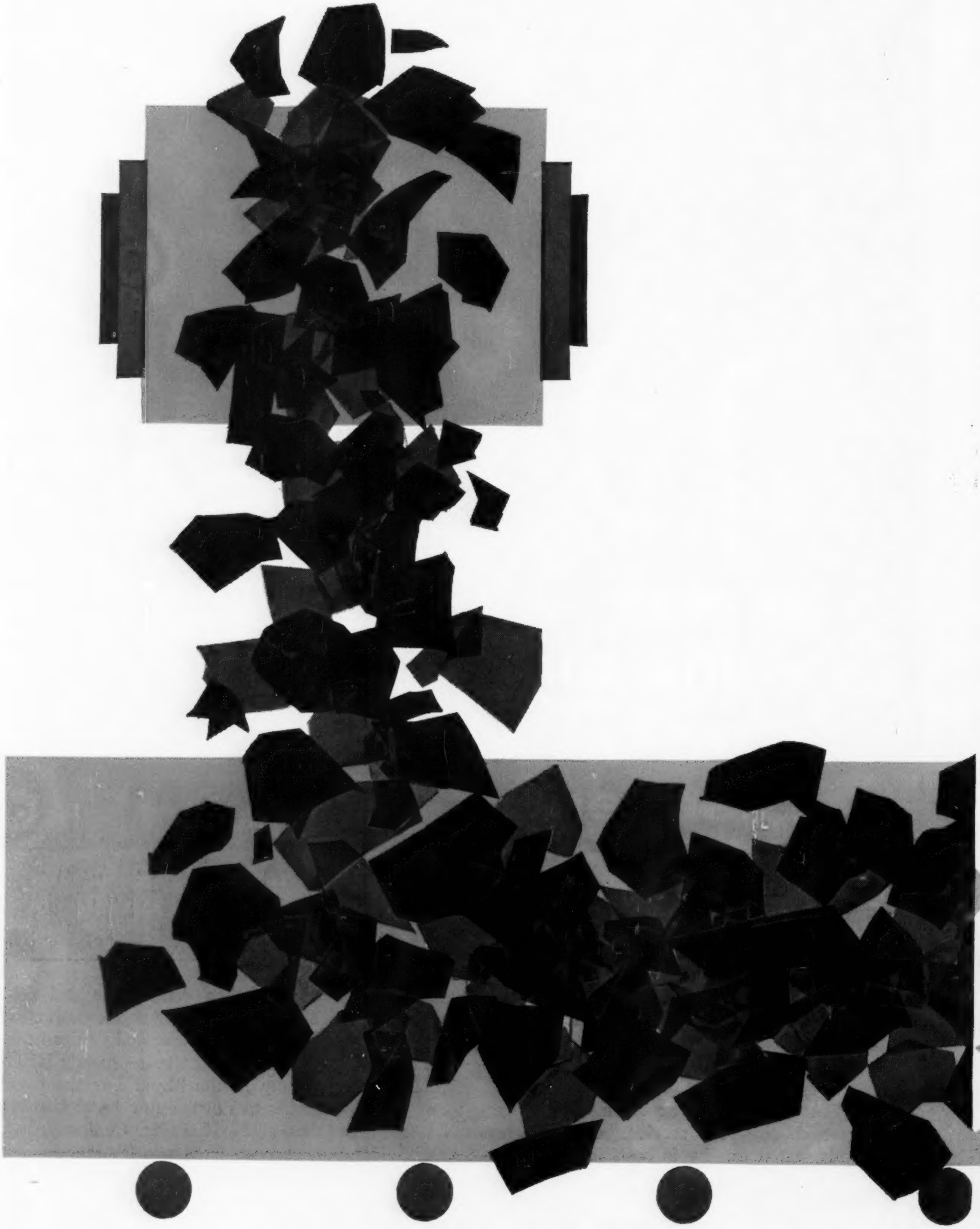

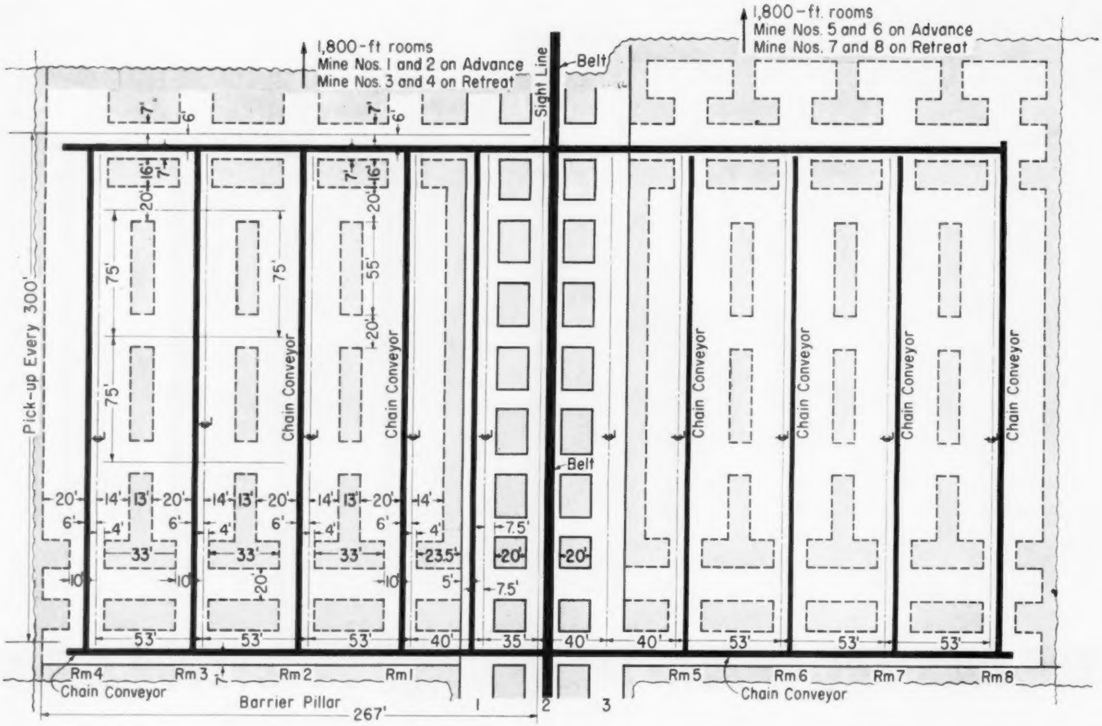

MINING PLAN at Saxsewell Div., Gauley Coal & Coke Corp., Richwood, W. Va., calls for developing room headings with conventional equipment and then mining 1,800-ft rooms parallel to the headings. Rooms are driven in pairs with twin-head auger-type thin-seam continuous miners. Mining sequence for rooms is noted on sketch. A full description of the Saxsewell mining system appeared in *Coal Age*, June, 1961, p 105.

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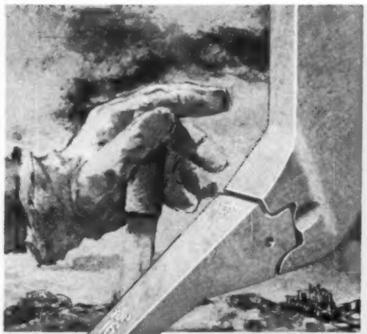

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ESCO Ripper Points	5½ hours	16 hours	4 hours	56 hours
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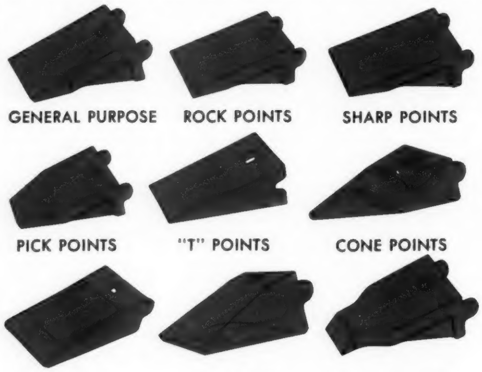

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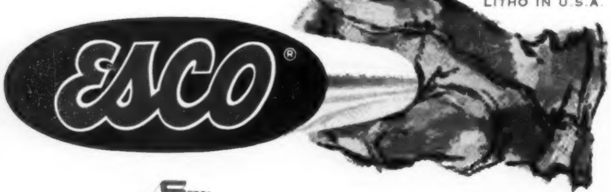

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1911 • FIFTY YEARS OF SERVICE TO COAL MINING • 1961

Devoted to the Operating, Technical and Business Problems of The Coal-Mining Industry

COAL AGE

JULY, 1961

IVAN A. GIVEN, EDITOR

500 . . . or Better

A MAJOR ITEM on the program for the 44th Annual Convention of the National Coal Association, in Washington last month, was "500 Million Tons—Where and How." It goes without question of course, that 500 million tons is only the first step for the bituminous industry. Practically everyone now concedes that there is growth ahead, though there is considerable divergence on just how much. But better than 500 million in the next five years or so—and possibly less—is a not-unreasonable goal.

The striking thing about the NCA presentation on ways and means of attaining 500 million—and more—was the key items on which stress was laid. They were: research, including development of burning equipment, public relations and marketing. Any somber student of the bituminous picture will find it easy to agree that these really are key items in attaining not just some growth for coal in the era ahead but the maximum growth possible. In contrast to phenomenal progress on the cost and quality sides, only a start has been made on the research, marketing and service aspects of coal mining. Only when they have been brought to the level of excellence of production and preparation will bituminous coal be in position to meet "The Challenge of Coal's New Growth Era" fully, and thus benefit to the maximum from the very real opportunities that lie ahead for the industry.

The First Million

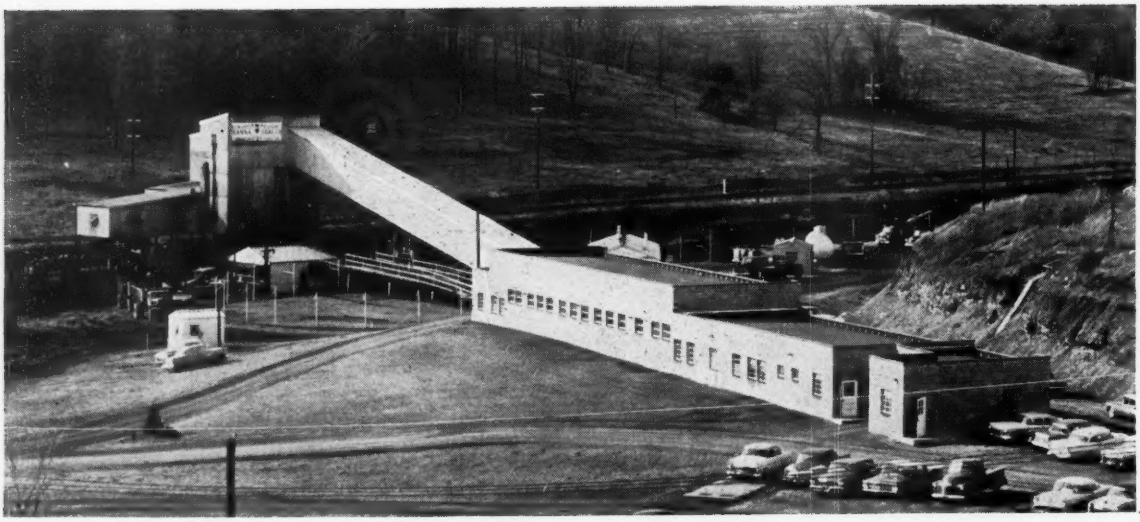
AMONG THE MILESTONES of 1961 of especial interest to coal is the fact that the number of electrically heated homes will pass the million mark. This was disclosed in the last survey of such heating by *Electrical World*, a McGraw-Hill publication, and reported on in its June 5 issue. And farther ahead? The *Electrical World* survey indicates that the total of electrically heated dwelling units in 1970 will reach or exceed 5,200,000. In addition, though this was not covered in this specific survey, there will be a significant growth in electrical heating of other types of establishments, plus a growth in such other forms of electrical heat use as melting snow on sidewalks and driveways.

Among the interesting items derived from this latest survey is the ratio of new electric home-heating installations to conversions of old homes. Conversions at the moment are running 24%. It is expected that the figure will reach 30% in 1970. It takes only a moment to realize that coal would have gotten none of the new homes and is gaining from most of the conversions. At a conservative figure of 7 to 8 tons coal equivalent per home per year, and giving one-third of the business to power generated from other fuels and water, coal now is enjoying over 5 million tons of new business and can look to 35 million or more in 1970. It ain't hay.

Hydraulic Outlook

EXPLOSIVES and electric power applied through bits, the latter being the principle of the continuous miner, are still not in any immediate danger of being challenged by any other form of mining in the U.S. —at least to any material extent. But one of the new contenders is hydraulicking, practiced to some extent abroad—primarily in the Communist countries—and being studied and experimented with for coal in the U.S. It already is being used most successfully in mining gilsonite in Utah.

The gilsonite vein is vertical, and logic leads to the conclusion that a prime application of hydraulicking would be in pitching coal, though there is no technical or engineering reason why it cannot be used in flat coal, though there might be an economic one. Pitching veins offer greater possibilities, however, and that is the reason for experiments in anthracite and in the inclined beds of Washington and certain other states. The time to successful commercial application might be as little as 2 to 3 years.

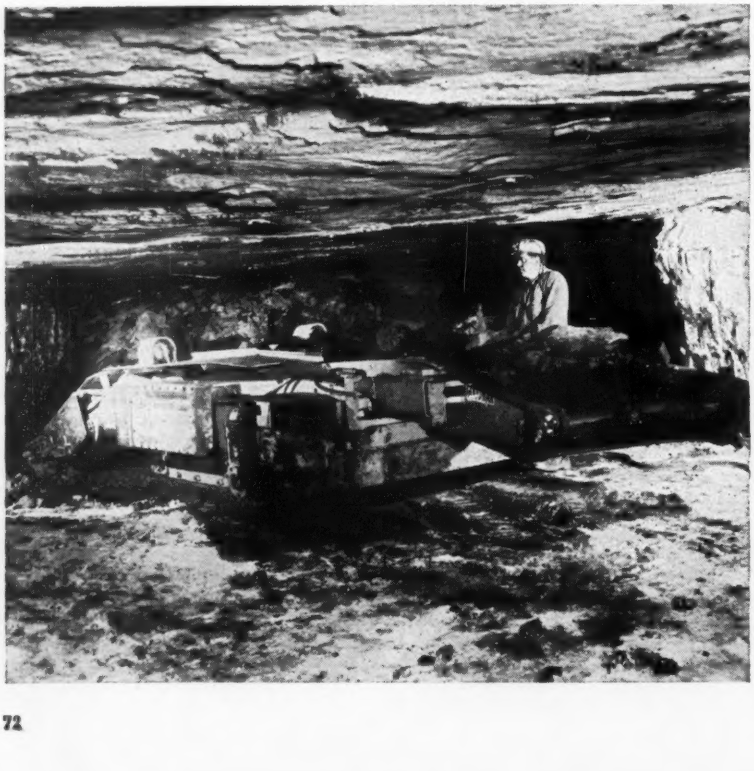


MAIN PORTAL is located along the Nickel Plate R. R. Slope belt discharges coal into railroad cars for delivery to Georgetown preparation plant. Glen Castle mine produces from the Pittsburgh No. 8 seam.

Efficiency and safety go hand-in-glove at Glen Castle in . . .

Getting 108 Tons per Face Man

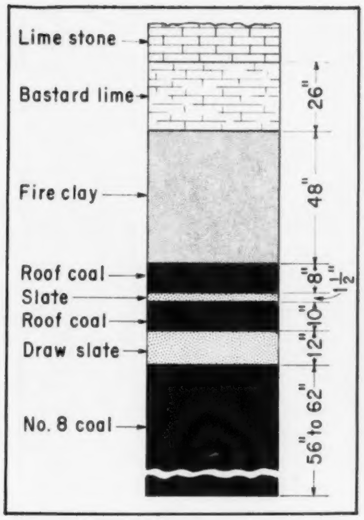
Hanna Coal Co. officials select conventional equipment and design mining methods that result in maximum safety, high productivity and low downtime.



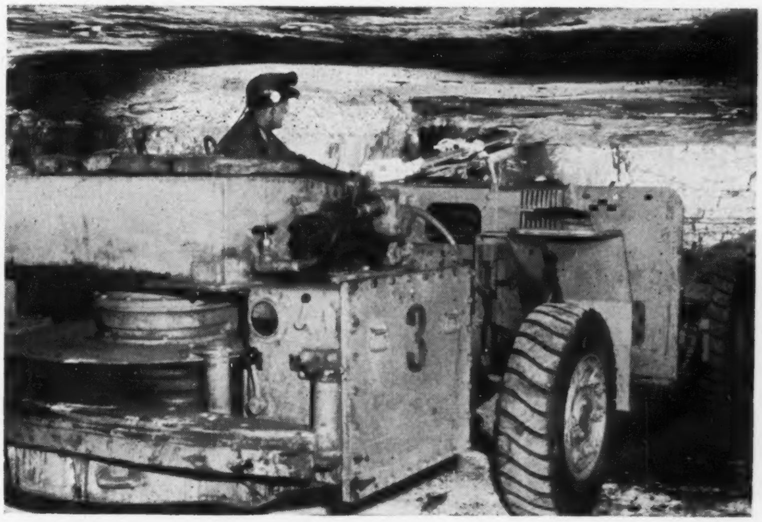
HIGH PRODUCTIVITY—108 tons of raw coal per face man, an outstanding safety record and systematic equipment inspection mark operations at Glen Castle mine, Hanna Coal Co., Cadiz, Ohio. In reaching this high level of productivity in offtrack sections throughout 1960 and thus far in 1961, Glen Castle has slashed its accident frequency to 4.05 and severity to 0.37. And equipment downtime averages only 3.71% of available work time.

Glen Castle is surrounded by abandoned mines which are filled with water and, as a result, water control is a major problem and must be taken into consideration in mine layout and mining methods. The mine taps a block of Pittsburgh No. 8 coal which originally had been allotted to the company's Dun Glen mine. But several years after the Georgetown preparation plant was built, management decided to recover the remaining 10 million tons of reserves from a new opening at a point along the Nickel Plate R. R. This new opening would

HIGH-SPEED LOADER fills a 7-ton shuttle car in 25 to 30 sec. Other high-capacity section equipment keeps pace with the loader.



TYPICAL CROSS SECTION reveals layers of friable material above the coal.

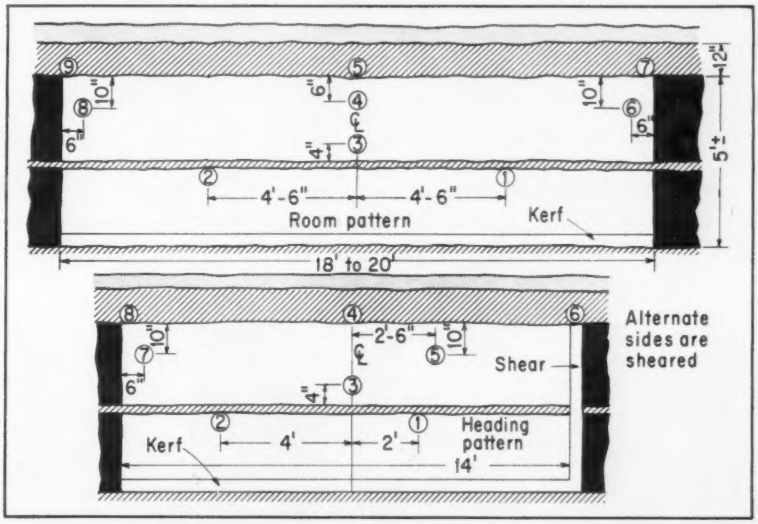


DRILL with 10-ft auger sinks a 3¾-in hole in coal in 50 sec. Self-propelled unit drills a hole in rock in 75 sec.

eliminate a long haul through entries which were originally driven for 7-ton mine cars and were now handling 10-ton units. Furthermore, acid water along the roadway was costly to remove because it ate through pipelines and pumps. By tapping the coal with a slope at the west end of the property, this long, expensive haul could be eliminated.

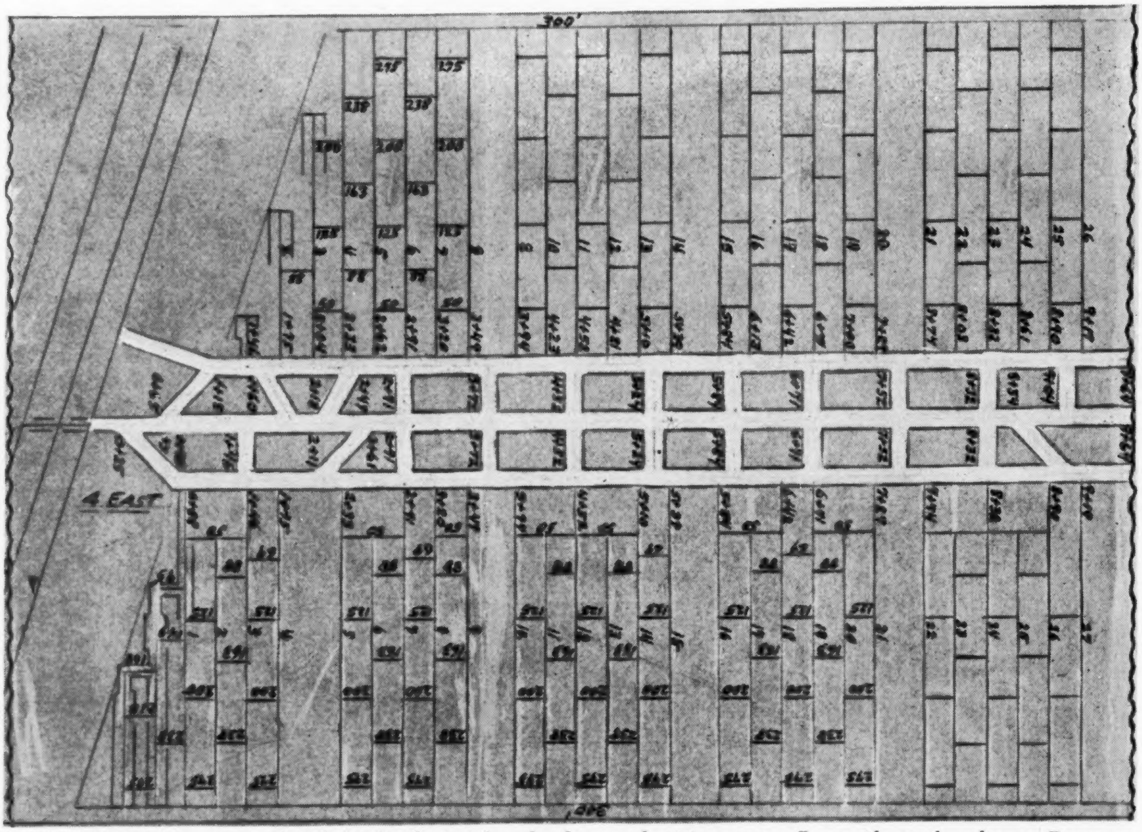
Knowing that water would be a major problem throughout the life of Glen Castle, Hanna engineers laid out a development and mining plan which would first concentrate work in the low area of the mine so that it could be used later for a sump. In November, 1953, workmen broke ground for the slope and by March 11, 1955, all underground construction around the rotary dump was completed and the 60-in slope belt was running. In January, 1955, development began in the south area which would serve as the sump for the entire mine. By July, production had climbed to more than 5,000 tpd.

Employing track-mounted equipment from the depleted Dun Glen and Willow Grove mines, section crews produced an average of 300 tons of clean coal per shift, or 492 tons of raw coal. But production was limited by the speed of the timbering crew, which had to set two 15-ft 60-lb rails



TYPICAL drilling and shooting patterns for rooms and headings are designed to produce a maximum of lump coal and break draw rock.

COMPRESSER AIR at 9,500 to 10,500 psi is used to break coal and draw rock. Shotfirer is inserting 3-in shell in left snub hole.



MINING PLAN for room panel includes developing three headings and mining rooms off one side on the advance. Rooms on other side are mined in groups of 12 on retreat. Pillars are not recovered.

GLEN CASTLE SUPERVISORS—Joseph Turkal (left), mine foreman; Henry Ciechomski, superintendent; Clyde Gibson, general superintendent; Dewey Piccin, safety engineer; and Carl Peltz, master mechanic, meet in Glen Castle office.

per 9-ft cut of coal. To overcome this bottleneck, the company initiated a program of roof-bolting early in 1956.

Production increased an average of 50 tons of clean coal per unit shift and all sections soon had roof-bolting machines. The original bolting plan called for two rows of 6-ft bolts to be installed in the centers of headings. But the mine experienced some roof falls and decided to go to 7-ft bolts. When all sections were equipped with roof-bolters, production increased to an average of 38 tons of clean coal per faceman, or 63.4 tons of raw material.

After the south area was mined out and converted into a sump, management studied the possibility of using offtrack equipment in areas being driven uphill, and ordered equipment for one section. The first offtrack unit, which went to work in February, 1958, included a Joy 11-RU cutter with a 10-ft bar, Goodman 966 loader, two Fletcher roof-bolters, a Joy CD 41 coal drill and two Torkar shuttle cars. Using this equipment, a 10-man crew boosted ouptut to 60 tons of clean coal per faceman in the first month, or 93 tons of raw coal. On the basis of the performance of the first unit, the company decided to buy more offtrack equipment. Today the mine has three offtrack units, the last two purchased having the higher-ca-

The Glen Castle Safety Record

Year	Frequency	Severity
1955	29.28	26.86
1956	25.48	13.18
1957	14.41	1.64
1958	4.79	0.21
1959	13.27	1.64
1960	4.05	0.37

pacity Goodman 967 loader in place of the 966. These offtrack units operate two shifts.

Glen Castle still has four sections equipped with track-mounted machines, which operate only on the day shift. These units work in areas with excessive water or where soft, wet bottom sharply reduces the effectiveness of offtrack equipment.

ROOF-BOLTING contributes heavily to high productivity and an outstanding safety record. Two units set 140 to 170 bolts per shift in each section.

Face Preparation

Mine management stresses that good face preparation is the key to getting consistently high production from the 56-in seam. Coal is bottom cut in rooms, and bottom cut and sheared on alternate sides in headings. Equipped with a 10-ft cutter bar and an 8-in bugduster, the universal unit makes a 9-ft cut. If a roll is encountered in the bottom before a place is half cut, the crew places a second cut immediately under the rock parting that splits the seam about 2 ft from the bottom.

It takes eight holes, five in coal and three in the draw rock, to break a 14-ft-wide cut. It takes six holes in the coal and three in the rock to break a room cut. The CD-41 coal drill has a 10-ft auger and sinks a 3 ¾-in hole in coal in 50 sec. It drills a hole in rock in 75 sec.

Coal is broken with Airdox at pressures ranging from 9,500 to 10,500 psi. The drilling patterns and shooting sequences for headings and rooms are shown in accompanying diagrams. As a result of good face preparation, management notes that a loader fills a 7-ton shuttle car in 25 to 30 sec.

The Mining System

The room-entry plan calls for three headings with rooms driven off one side on the advance and off the other on retreat. Headings are 14 ft wide on 50-ft centers and rooms are 18 to 20 ft wide on 29-ft centers. Six rooms are worked at a time on advance and are driven 300 ft deep.

As the headings advance all rooms are driven four cuts. When the headings have advanced 300 ft beyond the six working rooms, they are stopped until the six rooms are completed. A solid block of coal 25 ft thick is left between each group of six rooms to provide additional support for the friable roof. On retreat, the crews drive 12 rooms at a time, leaving a 25-ft solid block between the sixth and seventh rooms.

Loading ramps are made on both sides of the entry during development, one at the No. 3 room in each group of six which will be worked on the advance, and one opposite the solid block between the two groups of six to be worked simultaneously on retreat.

Shuttle cars unload directly into 10-ton mine cars which travel on track in the middle heading. Every 600 ft there is a runaround which can hold 12 cars. As a result, it is possible for a haulage crew to serve a section with little delay.

Two-man secondary haulage crews service two producing sections, and one man handles the trips between the mainline sidetracks and the rotary dump at the foot of the slope. A 27-ton locomotive pulls these trips to the dump at speeds up to 35 mph.

Offtrack section crews include the following 10 men: 1 loader operator, 2 cutting-machine men, 2 shuttle-car drivers, 2 roof-bolters, 1 driller, 1 shooter and 1 foreman. A 10-man crew in a track section includes 1 loader operator, 1 loader helper, 2 cutting-machine men, 1 driller, 1 shooter, 1 roof-bolter, 1 motorman, 1 trackman and 1 foreman.

Roof-Bolting

Glen Castle roof-support standards require six 7-ft bolts per cut and extra bolts in all breakthroughs so that they can be used for haulage. Bolts are installed 4 ft apart in cross rows on 4½-ft centers, the middle bolt in each row being set on the centerline of the opening. Bolts are ⅝-in high-tensile units fitted with Pal nuts, Ohio Brass expansion shells and 6x6x¼-in plates.

Since the coal seam is only 56 in thick, the 7-ft bolts must be bent, inserted part way and straightened before the installation is completed. To meet the companys bolting standards, two Fletcher units must set 140 to 170 bolts per shift in each section.

Mine management reports that bolting has contributed greatly in two ways to an improved safety record at Glen Castle. First, there have been no accidents resulting from roof falls since bolting has been practiced. Second, workers no longer handle heavy 15-ft sections of 60-lb rail and, as a consequence, bruised or broken fingers and toes, as well as back injuries, have virtually been eliminated. During the period when Glen Castle relied on conventional timbering, accident frequency was 27.48 and over a 3½-yr period with roof-bolting it was cut to 11.81.

Glen Castle management also stresses the gains in production that have been made possible because equipment works in an unobstructed opening which can be driven several feet wider. And it costs less to ventilate the bolted areas because of the decreased resistance to air flow. Roof support has been cut to $0.109 per ton from $0.186 since bolting has replaced conventional methods.

Accent on Safety

For its outstanding safety record, Glen Castle has received a series of awards, including the Industrial Commission of Ohio's Group Safety Award for contributions to safety by supervisors and employees in the statewide deep-mining classification. Since 1956, the mine has won this award for all but one 6-mo period. In addition, the property won the Joseph A. Holmes certificate of honor for operating a deep mine, 2,553,144 man hours without a fatality or permanent total disability from March, 27, 1956, to January 1, 1960. And this record is still being extended.

For reducing its accident-frequency rate by more than 50%, from 14.41 in 1957 to 4.79 in 1958, Glen Castle received the National Safety Council's Award of Merit in 1958. The mine also holds the U. S. Bureau of Mines certificate for 100% training in accident prevention.

To maintain interest in safety at a high level, Glen Castle management carries out the following four-point program:

1. The mine superintendent, safety engineer and foremen meet weekly to discuss hazards that have been noted in the past week and develop methods to eliminate them. They also outline a topic for discussion in the weekly underground section safety meetings, which are held at the start of the shift.

2. Each section foreman leads a 15-min discussion on safety once each week in his section. He writes a brief report of the meeting and lists the suggestions made by men of his crew. Management notes that by encouraging the men to contribute suggestions they get active participation in the safety program and keep everyone safety minded.

3. Hanna exchanges ideas with other companies in Ohio by participating in the monthly meetings of the Ohio Coal Association. At these meetings safety engineers from the various companies study all accidents in mines in the area, how they happened and how similar accidents could be prevented in the future. These ideas are carried back to Glen Castle for use in the safety program.

4. The general superintendent holds a monthly safety meeting with the mine superintendent, safety director, safety engineer and mine foreman to study all accident reports for the previous month. Special attention is directed toward any hazards previously reported, corrected and now reappearing. The aim of this meeting is to come up with a plan which will correct any reported hazard. Monthly section reports on mining conditions, practices and ventilation, which are prepared by the safety engineer, provide useful ideas for these meetings.

The Glen Castle safety engineer works under Hanna's safety director who reports to the vice president of operations and general manager.

Maintenance

Daily equipment inspection, a continuing equipment rebuilding program, and performance of major jobs on nonproducing shifts provide the foundation for an effective maintenance program at Glen Castle. Maintenance men work out of the underground shop and only perform emergency repairs on the section during a producing shift.

The master mechanic coordinates maintenance activities and assigns work to the shop crews on each of the three shifts. Details of carrying out the various jobs are handled by a maintenance foreman on each shift.

The master mechanic also makes a personal inspection of some of the underground equipment each day while it is operating. He notes items that need minor adjustment or repairs to prevent more serious trouble later. He also seeks comments from the section foreman on equipment performance that might be useful in preventing a breakdown. Information gathered from these inspections helps the master mechanic set up his maintenance schedule for the nonproducing shift, and also helps in planning major rebuilds.

Repairs during the producing shift usually are limited to those that can be done in 30 min or emergency repairs that will keep the machine running to the end of the shift. Permanent repairs are completed on the nonproducing shift.

Management notes that by concentrating on inspection and preventive measures, most maintenance can be done in the underground shop under favorable conditions. Working in well-lighted areas and with all types of tools, the maintenance men are able to do a better job in less time than would be required on the section.

The inspection and preventive maintenance program works so well that the mine is able to operate without a supply house. Only fast moving small items are kept on hand. Large parts are ordered well ahead of the time they are needed, and thus are available for a major rebuild job when the master mechanic orders a machine to the shop.

Bolt Recovery

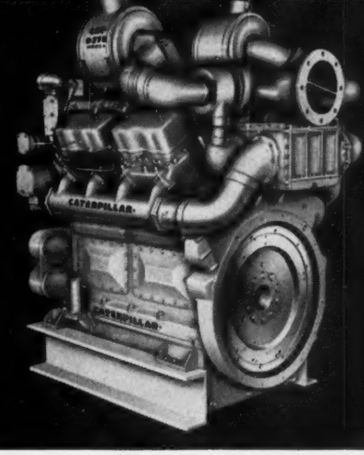
Glen Castle recovers 95% of all bolts for reuse. Two specialists, who have been trained in safety procedures, are employed regularly in this recovery work. One man sets safety posts in the area where bolts are to be removed and the other uses a post-mounted hand wrench to loosen the bolts. As soon as a bolt is withdrawn from a hole it is dipped in oil, fitted with a new Pal nut and expansion shell, and placed in a cart.

After recovering 25 to 30 bolts, the men haul them to an active working area. When a panel is on retreat, the men leave the recovered bolts in a room neck for removal by the supply crew.

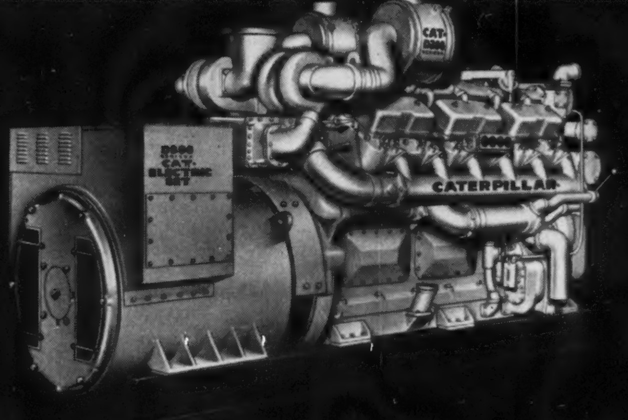
Somewhat concerned about whether bolts could be bent and restraightened and retain their strength, Hanna management ran a series of tests in cooperation with the U. S. Bureau of Mines. Test results showed that bolts have greater tensile strength in the section subjected to bending than in the section not bent and restraightened. In one instance the Bureau of Mines tested a bolt with 17 Pal nuts on it, indicating that it had been used at least 17 times, and found that the section which had been bent had greater tensile strength than the unbent section. Hanna engineers also have carried out tests in the company's central shop and results were similar.

engine power
BY CATERPILLAR

new Cat D398–D379



Cat D379 Industrial Engine. The 6.25″ bore, 8.00″ stroke D379 and D398 both offer the latest in attachments including marine gears and generators. The D379 Electric Set develops up to 350 KW continuous, 400 KW standby.



Cat D398 Electric Set. The D398 Electric Set shown here with Static-Regulated, Static-Excited Generator features a new generator with built-in static excitation system with no exciter generator or vibrating parts. Develops 500 KW continuous, 600 KW standby.

Give more horsepower per pound, per dollar than any other industrial engine in their class

The V12 D398 and the V8 D379 are rated at 950 and 630 maximum HP, respectively. Electric set versions reach to 600 and 400 KW. Marine ratings exceed 1000 HP. These engines are now available at prices that are less than crankshaft replacement prices of some competitive engines in their class.

Published list prices show the D398 to be thousands of dollars less than the next lowest priced industrial engine that will develop comparable horsepower. Other advantages are quality aluminum alloy bearings, aluminum pistons with cast-iron ring band for top two compression rings, drop forged-dynamically balanced crankshaft and high strength rigid block. These engines save in space and weight, too . . . with at least 35-40% less size and 4800 pounds less weight than other makes with comparable horsepower.

Here are more reasons why Cat D398 and D379 Diesels and Electric Sets give you extra value

NEW PERFORMANCE STANDARDS

- Turbocharged-Aftercooled design
- Static-Regulated, Static-Excited Cat Generators
- High flow lube and water systems
- Ability to burn wide range of fuels

NEW ENGINE FLEXIBILITY

- 100% HP from either end of engines
- Six available accessory drives – up to 50 HP each
- Controls available for either side
- Standard (counterclockwise) rotation or opposite rotation

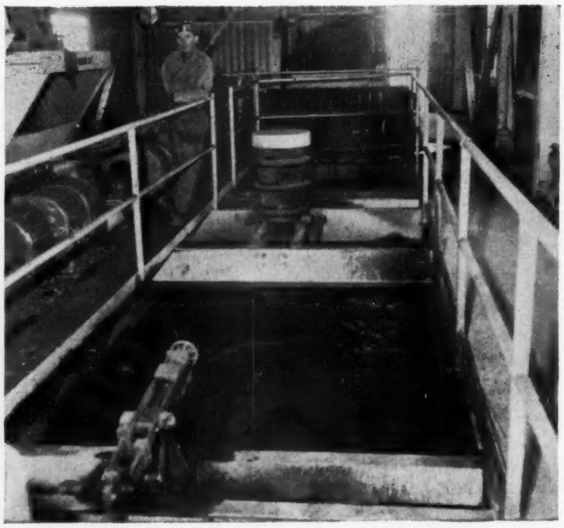
NEW SERVICE EASE

- Fuel or lube filters serviced from either side
- Remove heads without disturbing manifolding
- Easily inspect or remove pistons, rods and bearings through large side ports
- Externally mounted oil pumps for easy inspection and maintenance

For complete specifications on the D398 and D379 Diesel Engines or Electric Sets, contact your Caterpillar Dealer or Caterpillar Engine Division, Peoria, Illinois.

CATERPILLAR

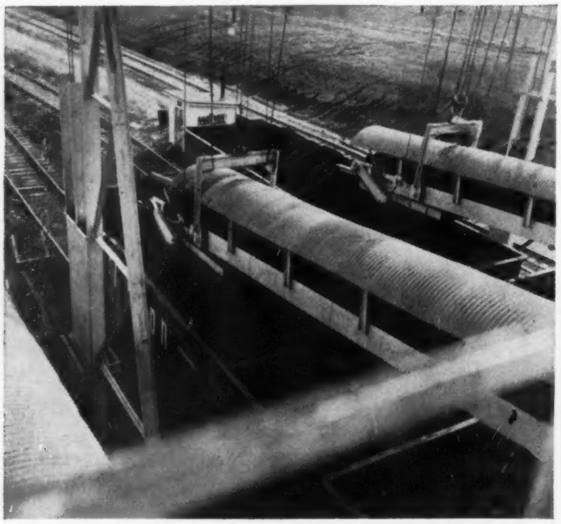
Caterpillar Tractor Co., Engine Division, Peoria, Illinois, U. S. A.

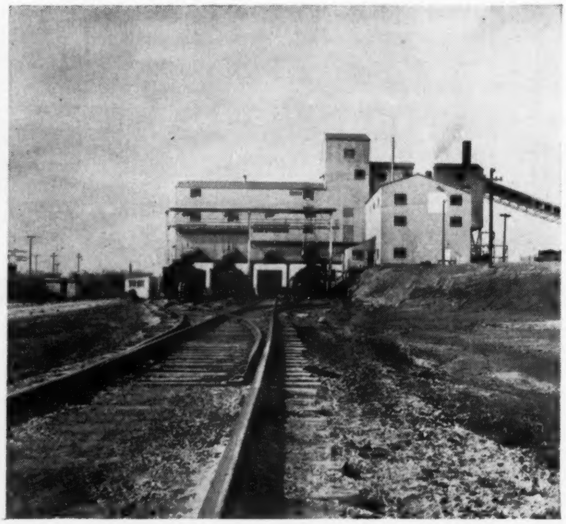


Allendale Highlights . . .

Efficient stripping . . .

Precision cleaning . . .



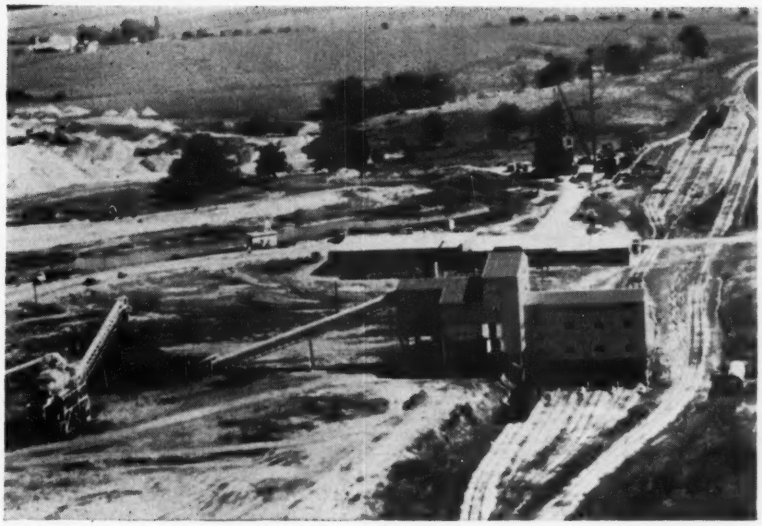


High capacity . . .

Excellent shipping . . .

Allendale: Stonefort's Newest In Northern Illinois

A STRIKING, blue-paneled preparation plant, set down in a well-planned service area, is one of the outstanding features of Allendale mine, Stonefort Coal Mining Co., Wyoming, Ill. This new producer in Stark County, north of Peoria, now adds 2,900 tpd to the fuel supply of the Midwest for industrial, public utility and commercial uses. Sale of the Allendale product is handled exclusively by Pittsburgh & Midway Coal Mining Co., 208 S. La Salle St., Chicago, Ill., and shipment is over either of two railroads, Chicago, Burlington & Quincy or Chicago & North Western. This network of rail lines provides access to all Midwest market areas and river-loading docks,



ALLENDALE preparation and service area is a model of good planning. Among its outstanding features are efficient coal-handling methods and equipment, buried utility lines and separation of truck, rail and auto traffic.

Well-planned service-area layout

Chicago and every major western port on the Great Lakes.

The mining company also operates a truck loading facility on Illinois Route 17 in Wyoming, Ill. Coal is switched to it from the mine by the Chicago, Burlington & Quincy. This facility serves local dealers and industries who prefer the convenience of truck delivery.

Stonefort, a strip-mining organization founded in 1954 by the late R. H. Sherwood, also operates Will Scarlet mine at Stonefort, Ill. Allendale is the newest in a series of mines named for characters in the legends of Robin Hood and his exploits in Sherwood Forest. In fact, the tradition traces to 1917, when Mr. Sherwood named his first strip-mining operation in Sullivan County, Ind., the Robin Hood mine. Now presiding over the affairs of the Stonefort organization is S. F. Sherwood, son of the founder, from headquarters at Indianapolis. The company was formed through a merger of Central Indiana Coal Co. and Little John Coal Co., both begun by R. H. Sherwood, whose long career in the industry is portrayed in the August, 1954, issue of *Coal Age*, beginning on p 60.

Present rates of production can be maintained for at least 20 yr in the Illinois No. 6 coal available to the Allendale stripping units. The employment roster includes 10 employees in supervisory and office management capacities and 53 miners.

Allendale Preparation

The preparation plant, was detail-designed and built by Roberts & Schaefer for jig washing, thermal and mechanical drying and close sizing; based upon an overall plant layout prepared by Stonefort's engineering department. It features a sheathing of plasticized galvanized steel, a Coal-Pak boiler for plant heating, color-coded interior finish, a fluorescent lighting system that can be controlled from any plant exit, interlocking circuitry on all coal-handling units to prevent spillover and an efficient raw-coal storage and feeding arrangment.

The sheathing (Stran Steel, furnished by National Steel Corp.) is factory-finished with a plastic coating, blue for the siding, gray for the roofing. Similar construction is used in service buildings, including employee's bathhouse, a large parts-storage shed and the combined office, warehouse, shop and garage. The office end of the combined structure is fronted in red brick. It is expected that the Stran-Steel will serve throughout the life of the buildings. The 50,000 sq ft of the steel which was required was supplied in 24-ga for siding and 22-ga for roofing, 1 yd wide by desired length.

The Coal-Pak unit, a BCR development, is rated at 2,400,000 Btu per hr. Seven New York Blower unit steam heaters are situated throughout the plant. The main advantage in the Coal-Pak system is that it will hold fire over a weekend without attendance.

All other buildings are electrically heated, which saves money on initial installation and eliminates subsequent labor costs for tending fires. There is the added bonus of evenly-applied heat to improve working conditions in the buildings and protect parts in storage.

Stonefort Management . . .

President	S. F. Sherwood
Vice President—Operations	W. W. Dukes
Vice President—Finance	T. H. Woodard

At Allendale . . .

Superintendent	Dora Sims
Mine Manager	Richard McFarland
Master Mechanic	Hubert Davis
Pit Foreman	Thomas King
Tipple Foreman	Russell Nicholls
Night Foreman	Harold Mackie
Mine Engineer	James Justus
Warehouse	Donald Langdon
Billing	Warner Hartman
Coal Testing	Clifford Powell

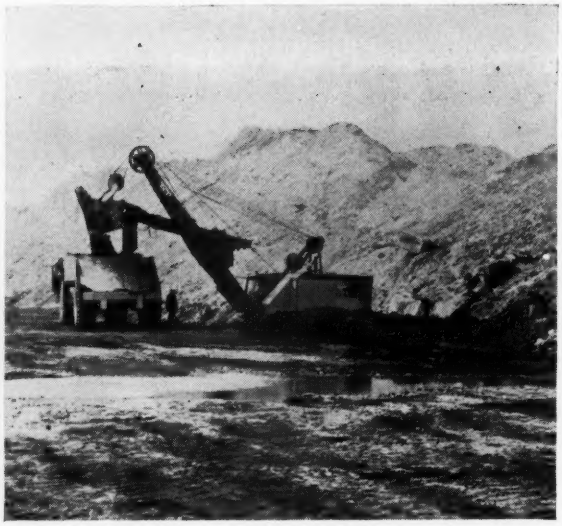
Raw Coal to Clean Coal

The procedure for converting the raw product from the pit into free-burning, high-quality fuel is as follows:

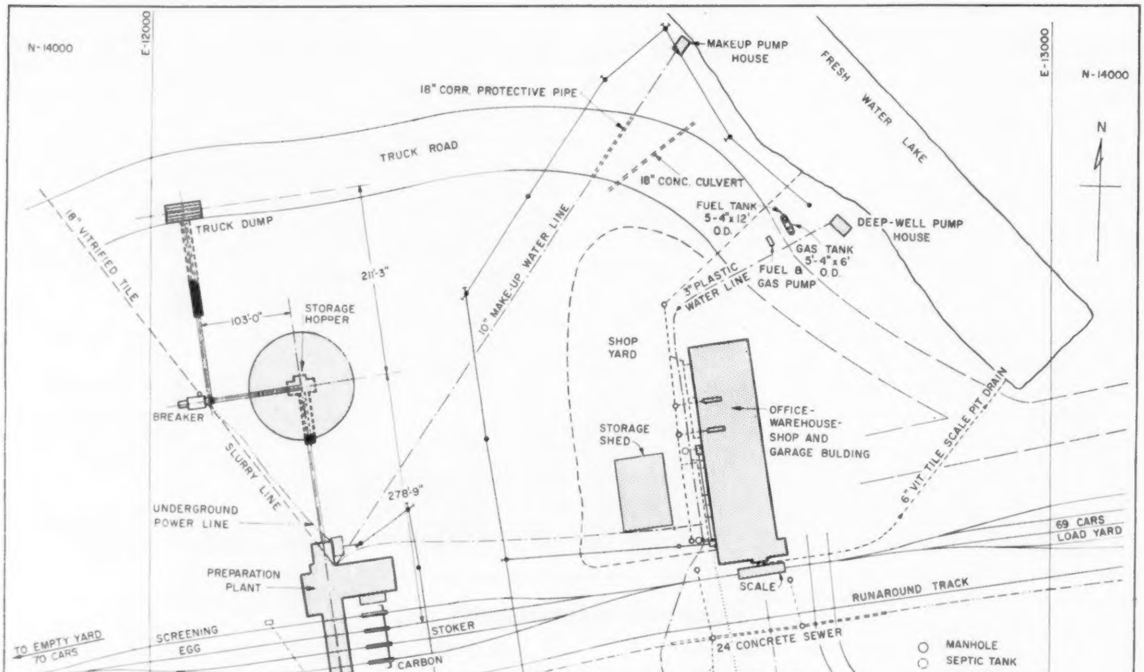
The 40-ton haulage units, brought to Allendale from worked-out Little John mine, discharge r-o-m into a 100-ton hopper in the storage area near the plant. A reciprocating feeder beneath the hopper delivers 650 tph to a 48-in elevating belt conveyor which discharges the material into a 10x18-ft Templeton-Matthews rotary breaker. Product of the breaker is 4x0 raw coal which is transported to the 2,500-ton stockpile on a 42-in stacker conveyor. The stockpile contains 1,000 tons in live storage and the remainder can be reclaimed in emergencies by bulldozing.

A double reciprocating feeder, remotely controlled from the plant, regulates feed to the plant at a rate of 600 tph. The weight of the 4x0 entering the plant is detected by a belt

BIG SHOVEL was purchased by Sherwood interests a quarter-century ago. It was overhauled and reinforced for Allendale.

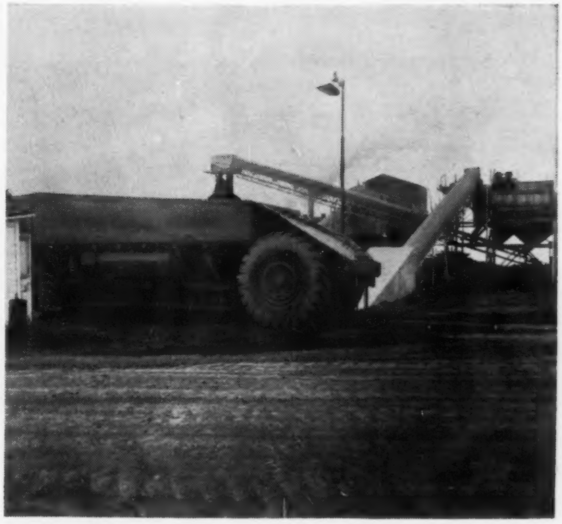


HIGH CAPACITY HAULAGE UNITS run on coal seam to and from 5-yd loading shovel. Haul is approximately 1½ mi.



PLOT PLAN of the service area at Stonefort's new Illinois producer.

HEAVY TRACTOR is equipped for dozing and ripping. Neither coal-loading nor overburden require use of explosives.



CUSTOM-BUILT breaker produces 4x0 raw coal for pre-plant storage pile. Total reject in processing is 27% of R-O-M.

scale and indicated on a dial at the operator's control station.

The coal is washed in a 7-cell Baum jig, the reject from all cells dropping directly into a 100-ton truck-loading hopper. Clean 4x0 leaving the washbox passes over parallel fixed sieves on the way to parallel dewatering and sizing screens. The stationary screens are topped with Bixby-Zimmer stainless-steel rod with 3-mm openings.

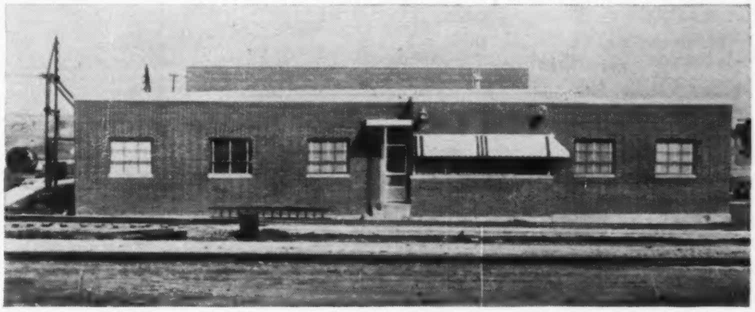
Overproduct of the primary screens may be loaded as screened, crushed and rescreened or mixed on the scraper conveyor to the loading booms. These possibilities are shown in the accompanying flow diagram, indicating the extreme flexibility of the preparation design.

Underflow of the primary screens, consisting of minus ¾-in clean coal, is fed over another pair of fixed screens to a pair of parallel single-deck vibrating screens which make a separation at the equivalent of ⅛-in round. The overproduct is conveyed to the mixing conveyor from where it may go to the dryers or directly to the cars; the underflow, ⅛x0, is dropped into the fine-coal sump, along with the water and minus 3-mm solids from all fixed sieves.

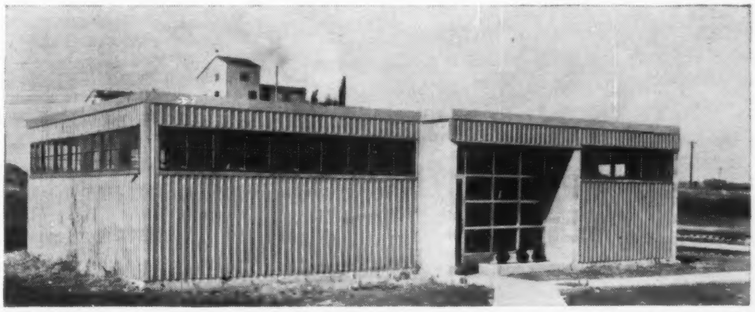
The four primary and fine-coal dewatering screens are 6x16-ft Link-Belt Straightline machines. Note that the ¾x⅛-in coal from the fine coal dewatering screens may be thermally dried in three Robert Holmes Baughman dryers when this treatment is specified. (R. G. Baughman, inventor of the dryer, is retired official of the Sherwood companies).

Material from the fine-coal sump is thickened in six 24-in R&S cyclones, then deslimed at 28M on a 6x16-ft Allis-Chalmers vibrator. The ⅛x28M deslimed product drops through an 8-in pipe directly into a Bird-Humboldt centrifugal dryer. The Bird-Humboldt product may be mixed and loaded, as is, or passed through the thermal-drying cycle.

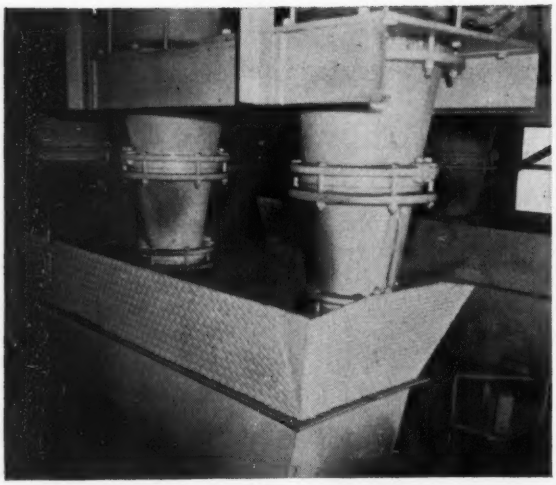
The crushing circuit, including two Gundlach adjustable crushers, is fed 4x¾-in coal, individually or combined, from the primary screens. The plant operator also has the option of bypassing the crushers to fill orders for coarse coal. In any event, the product of the crushers may be re-

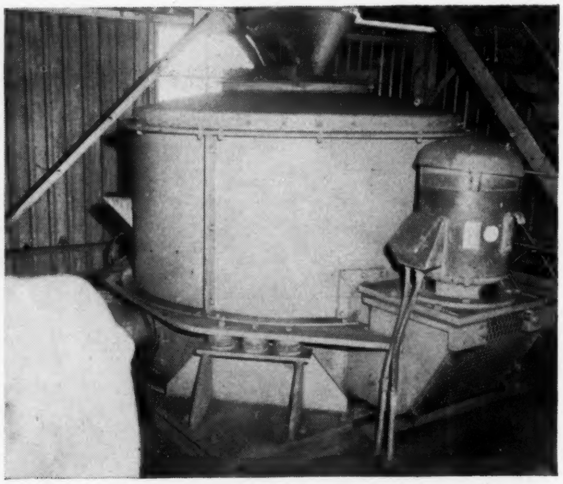


OFFICE and weigh-station occupy front portion of combined unit which also houses warehouse, shop and garage, all electrically heated.

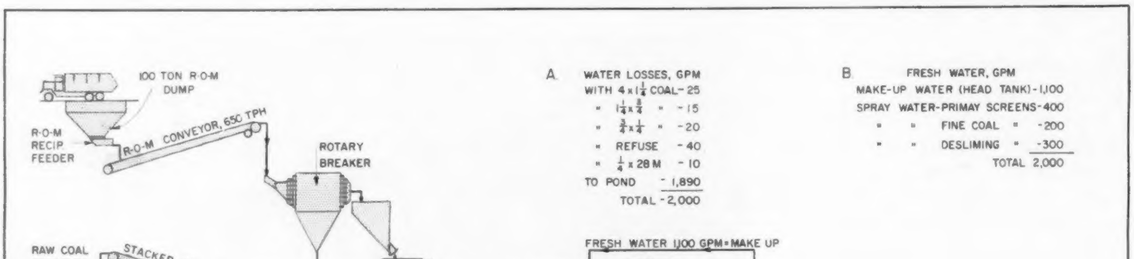


"BANK BUILDING" to Allendale employees is actually employee's bathhouse, fully equipped and electrically heated.





PRODUCT of six 24-in cyclones, deslimed at 28M, is piped directly to oscillating centrifuge to produce dewatered ¼x28M at a rate of 45 tph. Overflow of cyclones is directed to washbox head tank where it mixes with fresh makeup water.

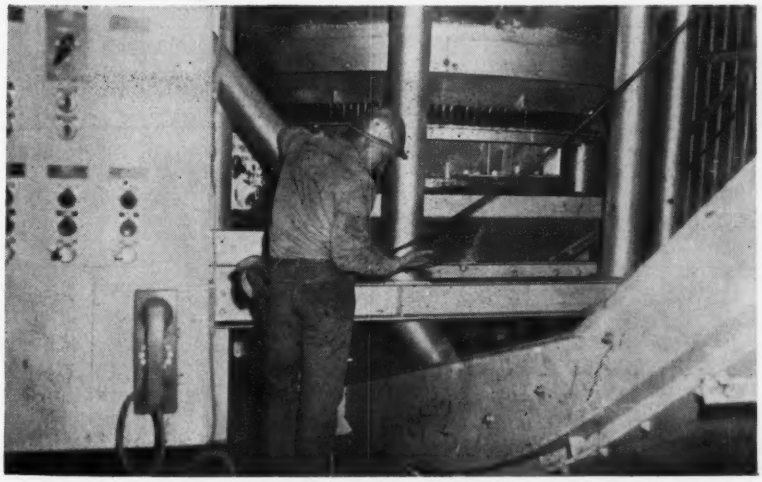


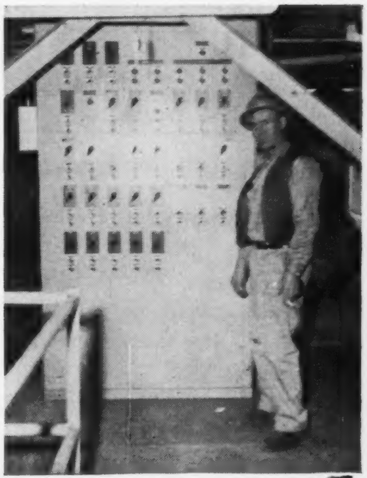
PREPARATION CIRCUITS and water balance in the Allendale plant.

screened on a pair of Allis-Chalmers Ripl-Flo screens to remove carbon from the stoker coal. This stoker coal may be selectively oil-treated at the discharge ends of the screens by means of a Henry O. Erb system.

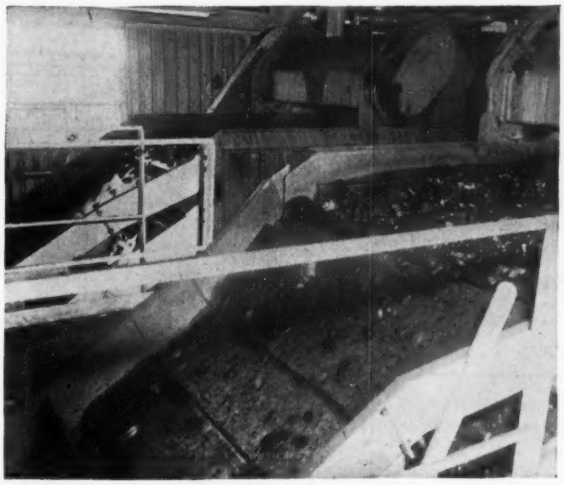
The plant water balance is shown in the flow sheet. The fresh-water pond (area-layout diagram) was one of the first installations at the new property. The black-water settling pond is in the initally worked sections of the pit and overflows clarified water into the fresh-water reservoir. This system is backed up by a deep well and pump adjacent to the fresh-water reservior.

Makeup water is pumped through





FOUR PLANT-CONTROL CENTERS are located at thermal dryers (left), washing floor (right), rotary-breaker structure and loading booms. In addition, plant equipment is automatically sequenced.



WASHED - COAL SCREENS provide feed for direct loading, crushing and rescreening and cyclone thickening. Oil treating is done at stoker rescreens.

a 10-in Transite pipe from the reservoir to one of a pair of 5,000-gal head tanks, the other tank receiving the overflow of the cyclone circuit. A common gravity discharge from both head tanks provides water for the washbox.

The safety of the employees in the plant has been given maximum consideration in the design. Even though the plant is compact there is ample clearance around operating units. The fluorescent lighting and the brightly painted interior improve "seeability." There are no dark corners in which hazards might lurk.

Foresight in planning the yard for empty railroad cars has contributed to better housekeeping with economy. At Allendale the tracks in the empty yard are separated by a distance sufficient to permit the use of a front-end loader for cleaning up the debris which is thrown from the cars as they are prepared for loading. Such clean-up is costly when it is done by hand labor.

Coal Recovery

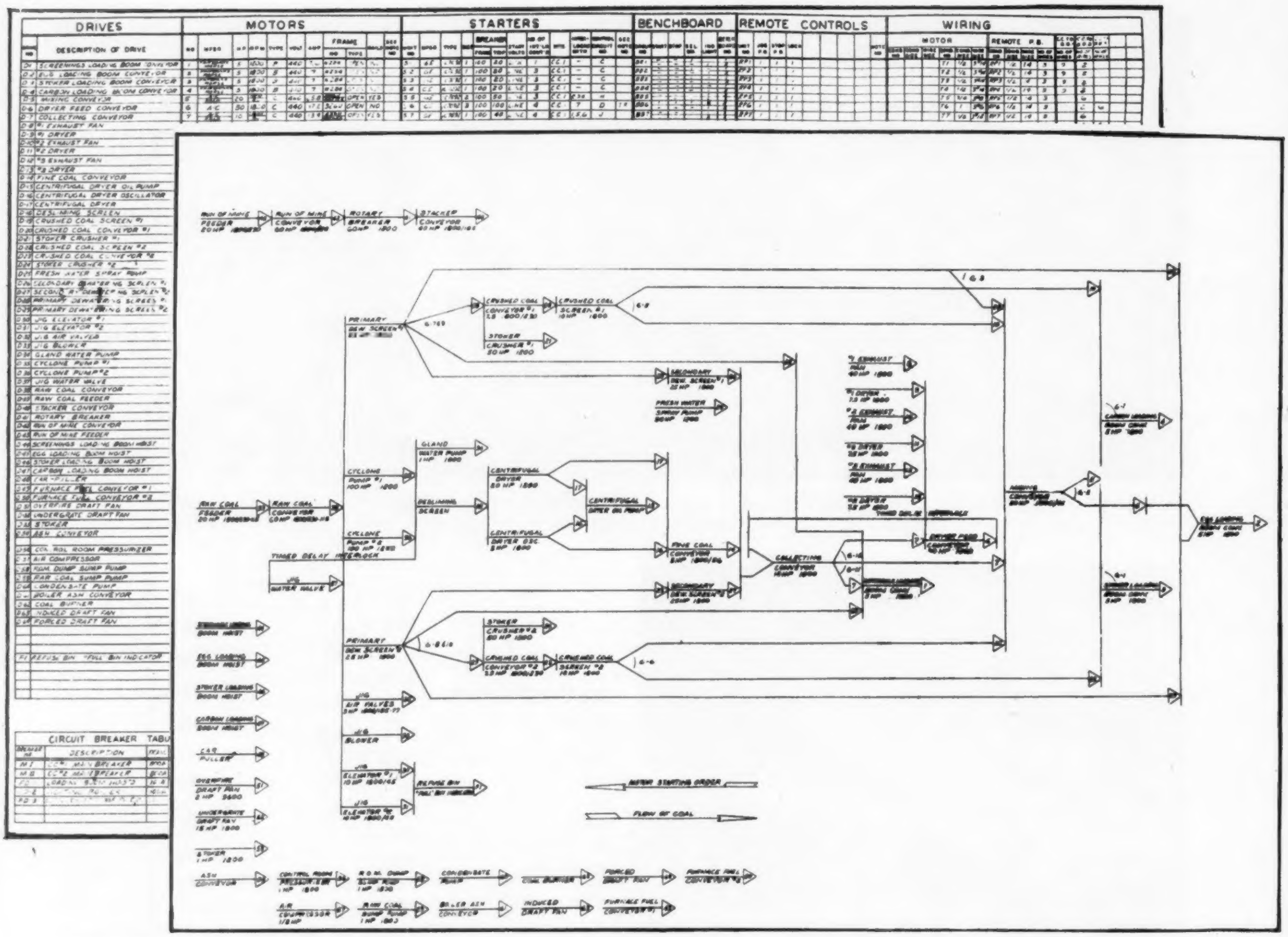
All of the Allendale overburden can be handled by the Bucyrus-Erie 950-B shovel (33-cu yd dipper) without a need for drilling and blasting. The cover on the 48-in No. 6 seam averages 50 ft in thickness, consisting of surface material, strata of shale and a thin sandstone near the coal. The shovel is capable of digging this entire column without prior blasting.

In the pit is a Caterpillar D-9 tractor equipped for bulldozing and coal ripping. Thus, the use of explosives is eliminated in "coal popping". On idle days, or on second shifts, the D-9 Dozer is used to rough-grade spoil as an initial step in pasture preparation. The overburden has been found by appropiate tests to lend itself to pasture utilization rather than reforestation.

The area now being stripped was formerly punch mined—not in any regular pattern—by local miners. The project will soon advance beyond these areas. In the meantime, large timber mats are placed in the old headings by the shovel itself as it makes its own right-of-way.

The original box cut was opened by an 6-cu yd dragline. The 950-B followed to work a pit averaging 60 ft in width. A 5-cu yd Bucyrus-Erie loading shovel loads out half the width of the pit along the spoil side, leaving the remainder of the coal as a haulageway which will be recovered in a following pass. Haulage units are 45-ton tractor-trailer units formerly used at the company's Little John property, now worked out.

The 950-B was purchased 24 yr ago as the Little John stripping unit with a 30-yd dipper. During its reconstruction at Allendale it was completely overhauled, including the addition of 1050-B features wherever possible. In the month of January, 1961, the big shovel averaged 10,050 bank yd per shift. In full-time operation this projects to 900,000 cu yd per month. The shovel now is working the pit with the ultimate objective of producing a long-term highwall having an outside curve, a step that will provide a substantial increase in



SEQUENCING DIAGRAM and underlying data sheet on motors and controls (by plant designers) are valuable aids in plant troubleshooting. The verticals from right to left in diagram show stages in sequence starting of preparation equipment.

available spoil room for the 950-B.

Stonefort employs two operators and a ground man on each of the three operating shifts. The two operators alternate hourly between running the shovel and oiling. Company officials point out that the shovel receives better care and operator fatigue does not become a limiting factor in production. The somewhat higher labor cost is no burden in the light of these benefits.

Allendale Services

The main service building, a structure measuring 250x70 ft, houses the offices, warehouse, shop and garage. The warehouse is the repository for small parts; large parts for the machines are stored in the 60x80-ft shed adjacent to the main building. The shop is equipped with machine tools sufficient to the tasks of regular maintenance.

However, some work is turned out to commercial repair shops, and Stonefort further participates in the equipment pool operated by strip-mine operators in the area. This plan, an outgrowth of the activities of the Open Pit Mining Association, provides that participants may borrow expensive replacement parts from each other to minimize downtime in emergencies. All companies in the plan are informed of the types of parts and materials in storage at other properties, thereby eliminating the need for a high inventory of spare parts at each mine.

Two bays in the garage are provided with subfloor pits for underside maintenance of heavy equipment.

Power is supplied at Allendale by Central Illinois Public Service Co. at a potential of 34.5 KV. The supply is metered immediately ahead of the mining company's own main substation.

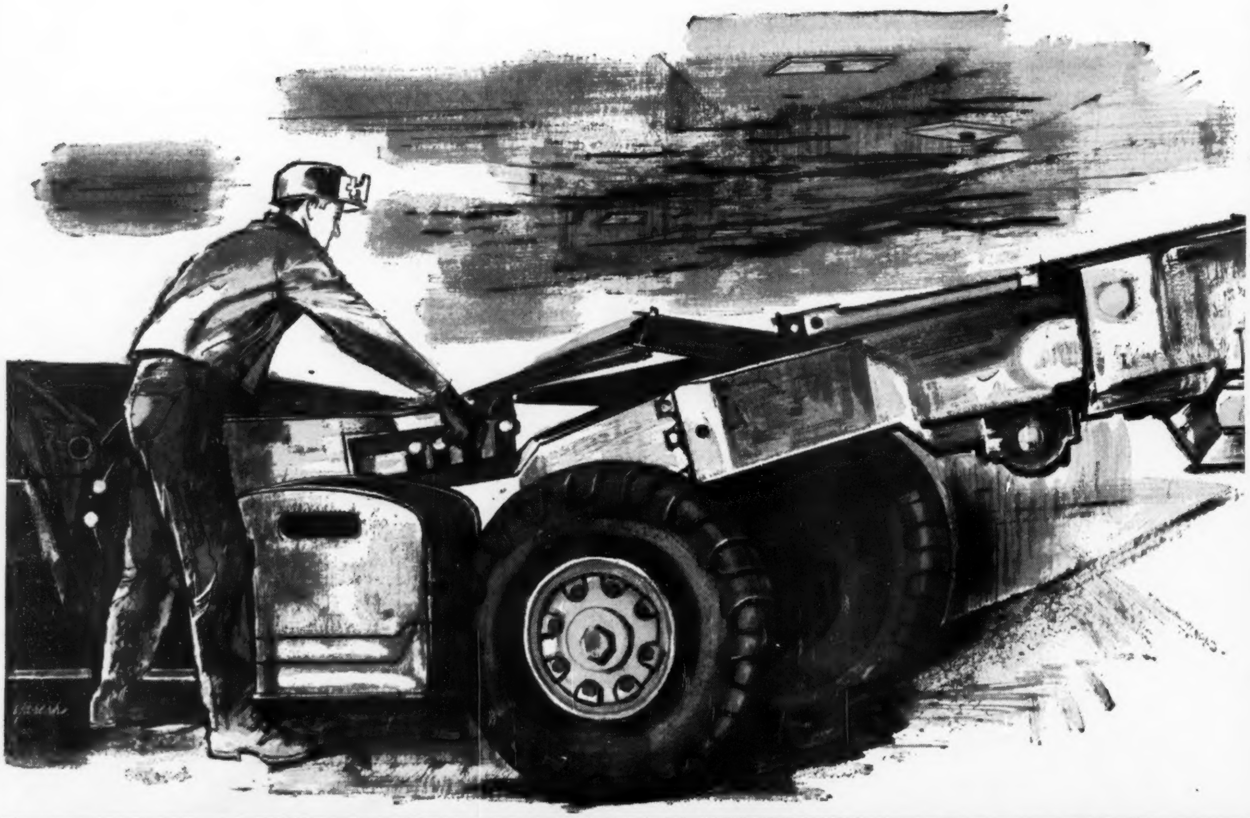
Major power lines in the service area are buried, except for a power line to the fresh-water pumps which is carried on poles. Individual substations are installed at the main building, the preparation plant and the employee's bathhouse. The 2,300-V power from the main substation is stepped down to utilization voltage at these installations, thus affording maximum economy in distributing power on the property.

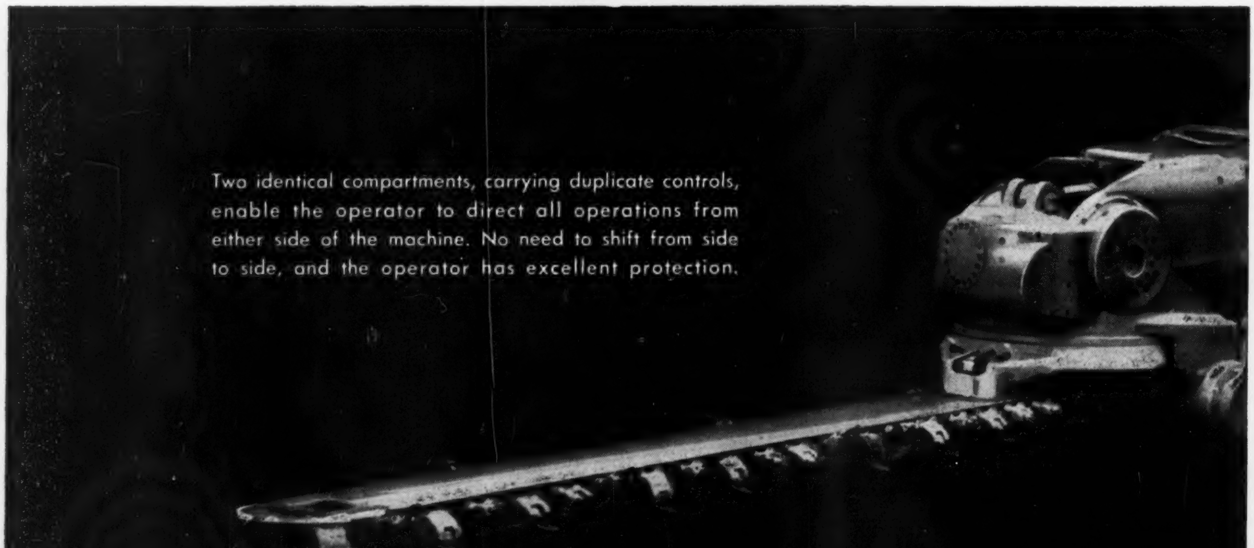
All buildings are electrically heated by thermostatically-controlled unit heaters. The Coal-Pak heats only the preparation plant.

In the spring of this year Stonefort officials began a thorough program of planting the service area in grasses and otherwise landscaping the property. The goal is to make the property a community asset.


THE USEFULNESS OF A LIMA
LIMA

JEFFREY UNIVERSAL COAL CUTTERS . . .

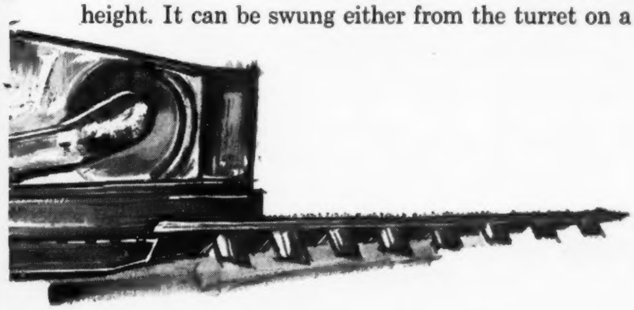




cut any place in the seam from 14" below floor level to 13' above

Jeffrey Universal Coal Cutters (AC or DC) are designed to meet various mine conditions and are available for working in mines with seam heights ranging from three feet to thirteen feet.

Jeffrey cutting machines mounted on rubber tires have a cutting head which can rotate and is instantly adjustable in height. It can be swung either from the turret on a long radius



or from the cutter head on a shorter radius. This permits bottom or top cutting any place in the seam or for making a shear cut right or left of center.

These machines feature the latest developments in coal cutting efficiency to give more workability without breakdowns... important advantages in getting higher production.

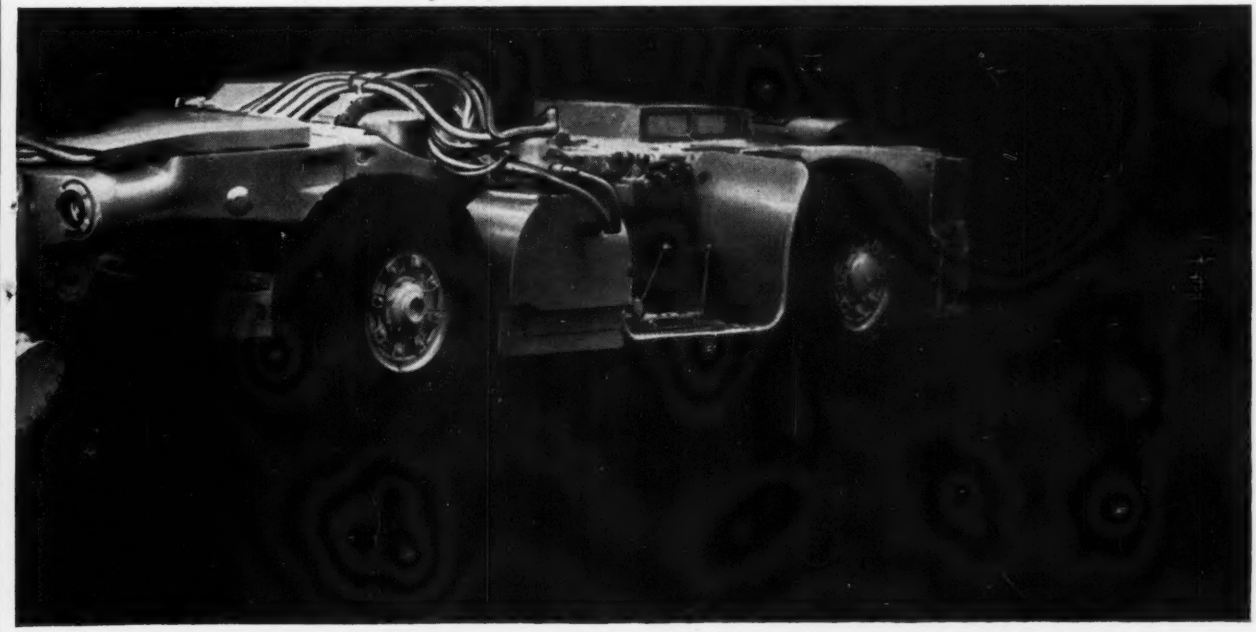
ADVANTAGES

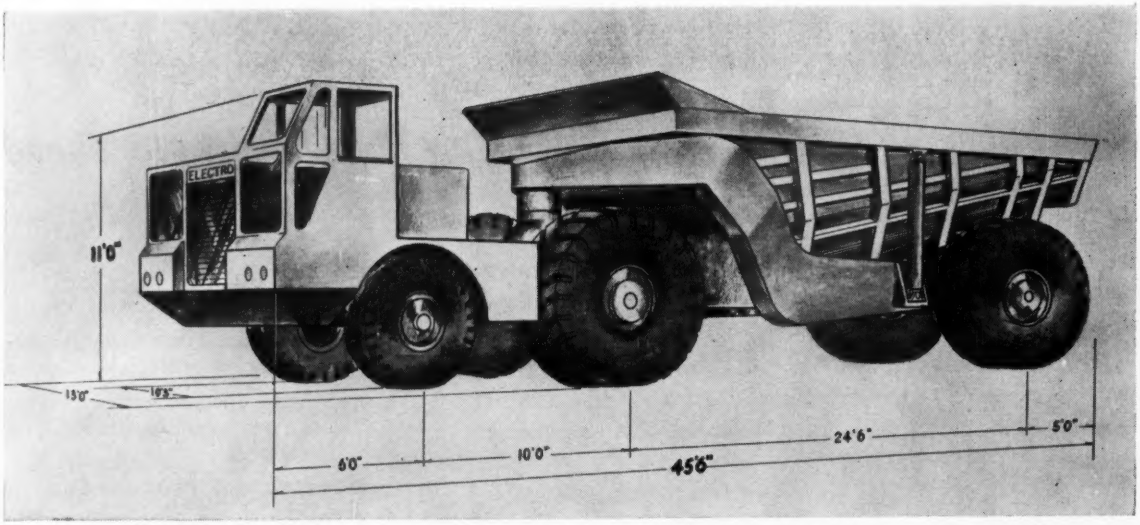
1. Full hydraulic control of all operations except cutter chain drive
2. Easy to operate and control—giving quick response from fingertip controls
3. Built for safety and speed
4. Designed for hard cutting
5. Constructed to stand up under rugged going
6. Have maximum flexibility and low cost operation—no operating time wasted
7. More smooth cuts per shift
8. Operating and control mechanisms are accessible for maintenance

JEFFREY

THE JEFFREY MANUFACTURING COMPANY
912 North Fourth Street
Columbus 16, Ohio

If it's conveyed, processed or mined, it's a job for Jeffrey.





HAULAGE UNIT for metal mining uses engine-driven generator to supply power to a flange-mounted motor driving intc each of the wheel reduction units. This tractor with an unmotored trailer could be a coal hauler.

Applying Electric Drive To Coal Haulers

Growing size of coal haulers creates opportunities for use of "motorized wheels." Advantages are lower-cost maintenance, high efficiency and high capacity.

R. W. Volpe
Locomotive & Car Equipment Dept.
General Electric Co., Erie, Pa.

PRODUCING COAL at low cost requires high-capacity, reliable, efficient machinery. In stripping operations, every year brings the announcement of the installation of a new larger shovel. In haulage, the vehicles have increased in size from 20- to 50-ton capacity. Each change in size was brought about by the pressure of economics. The operators were shown (Fig. 1) a potential savings for changing to the next larger size truck which was attractive enough to eventually result in the new vehicle becoming the industry standard. This process has been repeated a number of times with the only basic modification to the concept of a coal hauler being the change in capacity. The performance as measured by hp per gross ton and maximum geared speed has not appreciably been improved. The efficiency of the drive trains show no great improvement. Unfortunately, maintenance costs on the larger vehicle, particularly the drive line maintenance expense, have increased at a

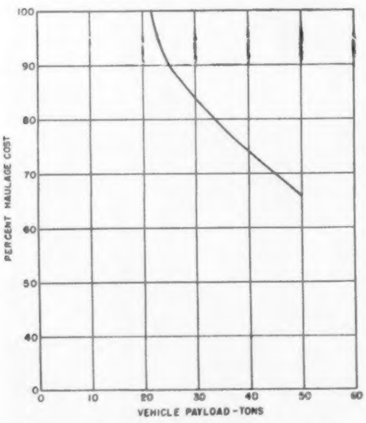


FIG. 1–HAULAGE COST vs. size.

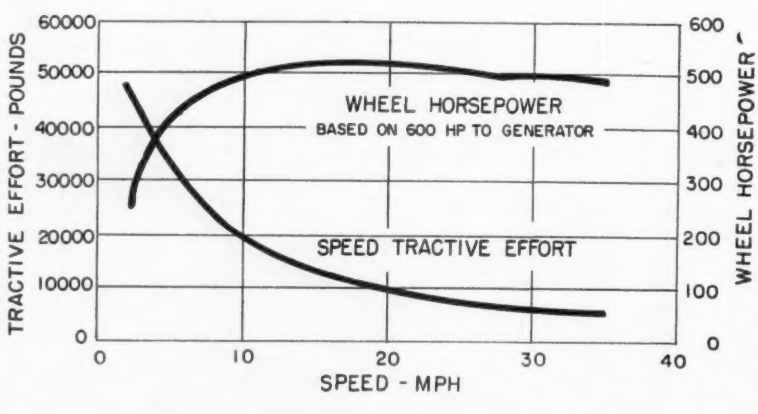
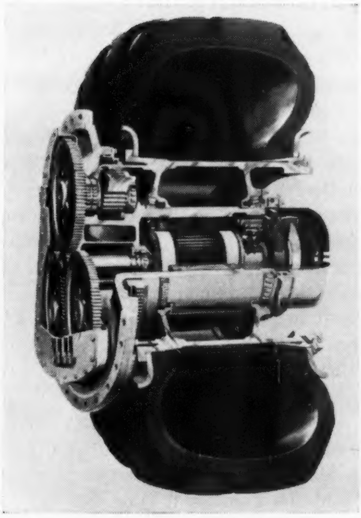
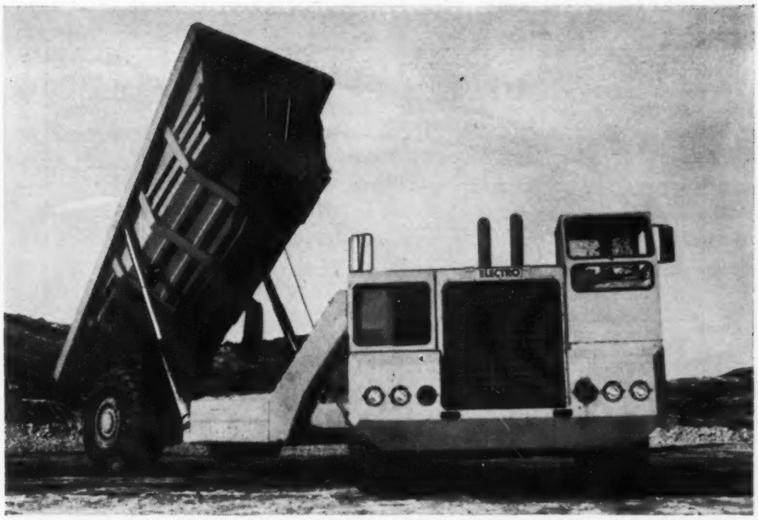


FIG. 2–ELECTRIC DRIVE performance characteristics.



MOTORIZED WHEEL utilizes motor magnet frame as load-carrying member.



FOUR motorized wheels power this 55-ton rear-dump hauler. Tires are 37.5x33. This one operates at a Minnesota iron-ore mine.

rate greater than the gain in productive capacity. In addition the effects of fixed hourly charges, such as operator wages, become relatively less important on a per ton basis as vehicle capacity increases. For these reasons, the cost curve is tending to level off for the larger vehicle.

What the operator would like to have is a vehicle of large capacity with high performance, reliability and low maintenance expense, to maintain the earlier rate of haulage cost reduction. Electric drive makes such a vehicle practical. Electric drive has proven in every industry, including mining, that it is the reliable, high performance low maintenance drive. It is only recently that several major vehicle builders and users have elected to apply the advantages of electric drive to rubber tired haulage vehicles.

In the original applications the ability of electric drive to absorb high overloads for short times was put to use in climbing steep grades at speeds higher than previously thought practical.

But performance as expressed in terms of hp per gross ton is most important in getting the coal hauler up to speed and maintaining a high speed on the haul road. The efficiency with which the drive handles the power delivered to it at the engine flywheel is a corollary parameter. In fact, vehicle performance should be judged not on the basis of engine hp per ton but more correctly on the horsepower at the wheel, which is the useful horsepower, per ton of gross weight.

The shape of the horsepower utilization curve is also important where the vehicle is operated over a rolling profile which causes the vehicle to balance out at different speeds in relatively short travel distances. Drive systems which link vehicle speed to engine speed can only deliver full engine horsepower to the wheels over a very narrow speed range resulting in poor vehicle performance on average haulage cycles which demand a range of balance speeds for the varying grades.

A typical two motor electric drive characteristic is shown in Fig. 2. The horsepower utilization curve is essentially flat over the range of operation of a fully loaded vehicle where power demand is most critical. The operator can measure the effects of higher available wheel horsepower in an actual operation by comparing the number of vehicles required to move his tonnage and the total charges per ton hauled.

Performance Ratings

A typical operation for such a comparison might require haulage from pit shovel to power plant of 5,000 tons of raw coal per shift over the profile shown in Fig. 3. This fairly short haul would normally be considered to favor standard size vehicles over any large capacity unit. Therefore, any predicted advantages for the larger truck in economy will be minimized in this comparison.

One vehicle builder has offered a large electric drive vehicle which may

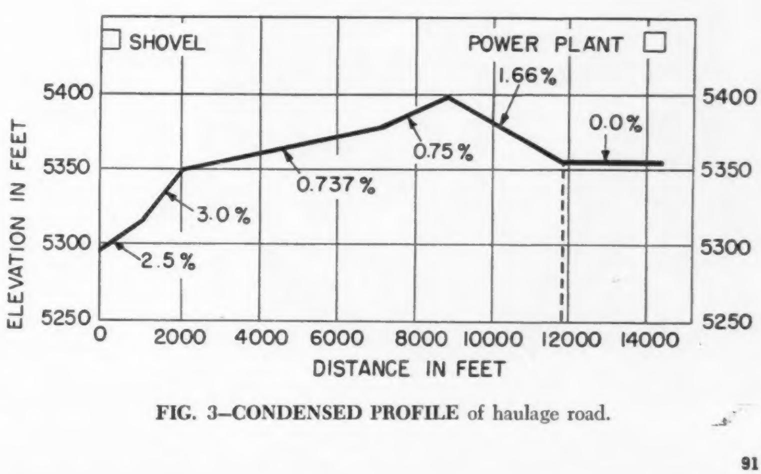


FIG. 3—CONDENSED PROFILE of haulage road.

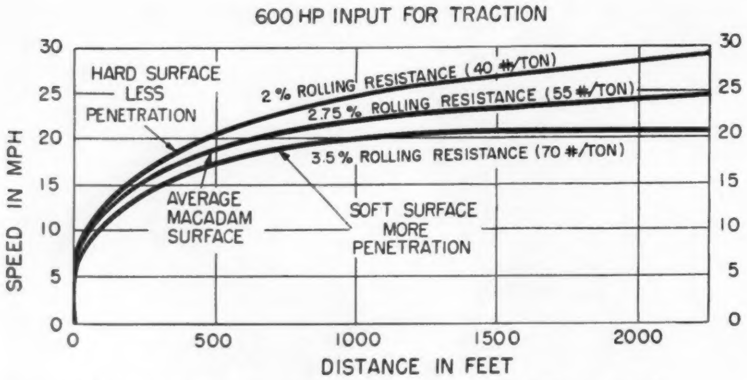


FIG. 4—COMPARATIVE acceleration curves for 135-ton vehicle.

be compared with a conventional vehicle in this typical mining situation. The two vehicles have the following general characteristics:

	Diesel Electric	Conventional
Gross weight, tons	135	116
Payload capacity, tons	90	80
Tare weight, tons	45	36
Engine HP	600 (HP to Gen.)	450 (HP Gross)
Maximum Speed, mph	35	40

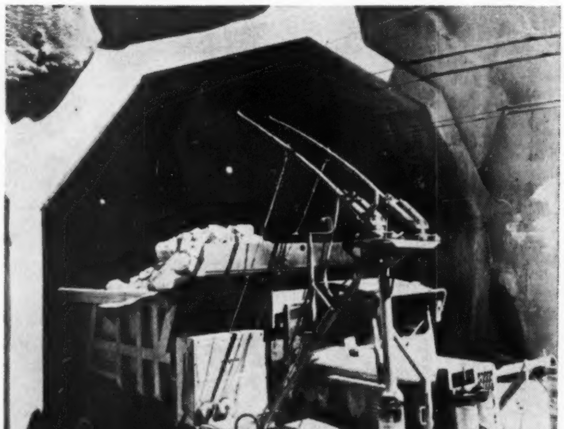
Both fleets are to operate over the typical profile and will be loaded by a 10-yd shovel with a cycle time of 28 sec. The rolling resistance of the roadway for both vehicles is estimated at 55 lb per ton. The value assumed for rolling resistance has a serious effect upon the estimated vehicle performance. As shown in Fig. 4, a change from 2% to 3.5% rolling resistance increases the distance traveled to accelerate to 20 mph from 475 feet to 1,250 feet on level roadway for the fully loaded 90-ton vehicle. To accurately determine the time it takes a vehicle to cover a given profile, the actual performance of the vehicle should be calculated from its speed-tractive characteristics for each change in grade on the haul road.

A very rough approximation of performance can be obtained by calculating the balance speed of the vehicle on each constant-grade portion of the cycle and adding or subtracting the estimated inertia effects affecting the vehicle on that portion of the haul. On profiles with short pitches of adverse and favorable grades, this method leads to considerable error. A more exact method is to calculate for various vehicle-speed conditions the tractive effort available for further acceleration and thus determine accurately the time and speed attained over a given distance. A sample calculation most easily demonstrates the method.

Assume the loaded diesel electric truck encounters a 3% grade, 300 feet in length at 3 mph, how long will it be in the grade and what will be its true final speed?

With 55 lb per ton rolling resistance the 135-ton truck will have a theoretical balance speed when tractive effort available equals total resistive forces of 12.25 mph.

The average tractive effort available for acceleration (tractive effort available at the average of initial and balance speeds) is 7,475 lb which provides an acceleration rate of approximately 0.55 mphps. To accomplish the 9.25 mph change in speed at this acceleration rate requires 16.7 sec during which time the vehicle will have covered 186.5 ft. The truck



ELECTRIC TRUCK with 30-ton capacity serves underground mine at Riverside, Calif.

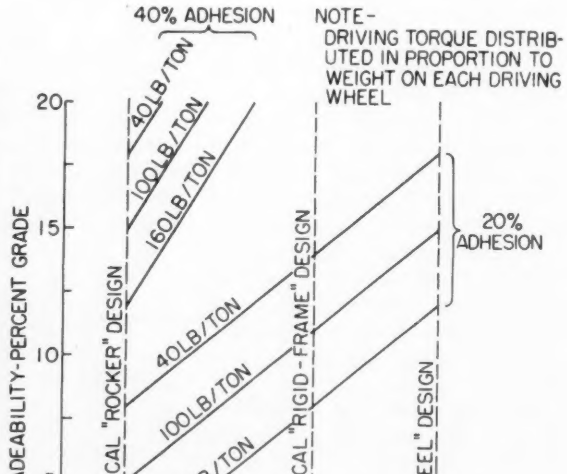


FIG. 5—EFFECT UPON GRADEABILITY of percent weight on drivers, percent adhesion and rolling resistance.

running at its balance speed of 12.25 mph covers the remaining grade haul in 6.3 sec for a total time on the grade of 23 sec. The balance speed approximation method would have yielded a time on the grade of under 17 sec or an error of over 35%.

Operating Cycles

Using the speed-time-distance method, the diesel electric vehicle can be calculated as having a loaded running time of 423 sec and a return time of 291 sec. Similar calculations can be made for the typical conventional coal hauler over the same route with a speed-distance characteristic as shown in Fig. 4.

The two vehicles, using this method, would cycle as follows:

	Diesel Electric	Conventional
Loaded Haul, Sec.	423	714
Empty Return, Sec.	291	258
Load, Dump, Turn, Sec.	344	313
Total Cycle Time, Sec.	1058	1285
Trips/Shift (8-50 min hours)	22.7	18.7
Tonnage per Truck per shift, tons	2,043	1,496
No. of Trucks Required	2.9	4.0

If the 90-tonner had been designed around standard vehicle concepts of performance, the theoretical difference in units required would be a mere fraction of a truck. By offering a high performance vehicle as well as high capacity the number of trucks required can be reduced by a real integral value. While fewer high-performance, large-capacity trucks will be able to handle the required production, the hourly capital charges on the investment are only part of the total haulage cost. The total driver expense for the fleet will be lower than with small standard trucks. These savings should consider also fringe benefits which make an appreciable addition to direct wages.

Hourly maintenance expense on the larger higher horsepower engines will be greater than for the 80-tonner but on a cost per ton hauled basis the charges will be lower. Similarly, fuel consumption per hour will be higher, but on a per ton basis, fuel consumption will be lower. Tire life, on the 90-tonner using single tires should be equal or longer to that obtained on the standard vehicle if the experience of electric drive vehicle users in other mining operations is realized here. The large single tires cost more than their equivalent rating in duals but the added productivity of the vehicle equates this maintenance item on a cost per ton basis.

Drive maintenance will be greatly reduced over that reported by many users of hydraulic torque converter drive trucks. Your own experience with electric drive on shovels indicates the reliability and maintenance you can expect with properly designed and built rotating and control equipment. Similar traction type motors on the mainline U.S. railroads regularly go 500,000 miles before being removed for overhaul. Brush maintenance with clean ventilating air forced through the rotating machines is drastically decreased.

Quantitative cost studies made for many initial mining operators indicate equal or lower total hourly maintenance expense per vehicle for diesel electric vs diesel torque converter trucks. The real criterion is cost per ton moved. The high production of the electric drive vehicle results in total lower cost per ton. Successful application of large, high performance trucks and the realization of the low cost haulage attributed to them requires that they have maximum availability with a minimum of downtime for repairs, inspection and servicing. Electric drive has given that reliability to stripping shovels and draglines; adequately designed and properly built electric drives are building the same reputation for trouble-free operation in both trolley-powered and diesel-electric truck applications.

Normally, electric drive is considered when it is desired to power all wheels on a vehicle. In metal mining where grades are steep and grade ability is of prime consideration, electric drive provides the maximum driving torque by powering all wheels. The effects on grade ability by powering the lead axle on a two axle tractor-trailer combination or the trailing axle on a standard truck or by powering all wheels on a vehicle are shown in Fig. 5.

With the low grades normally encountered in coal operations the advantages of all wheel drive are minimized. If the truck operates on the fire clay or where soft bottoms are a problem even though grades are almost non-existent, electric drive on all wheels will provide the additional tractive effort required at low speeds. On the haul road, the drive would switch to two wheel drive for maximum speed.

Electric Truck Types

Electric drive for trucks may take several forms, depending upon the desired vehicle configuration and size. One approach to electrifying the drive on a vehicle is to remove the clutch and transmission, and substitute a direct engine-coupled generator to supply the power and a motor to drive into the standard differential on the "tractor." A similar motor, differential and planetary system may be installed in place of the trailed axle which normally would be unpowered. A further refinement in the electrical approach is to eliminate the differentials, axles and drive lines by having the engine-driven generator supply power to a flange mounted motor driving into each of the wheel reduction units. The vehicle shown in the first illustration is of this type for metal mining. The same tractor towing an unmotored trailer becomes the coal hauler used in the above comparison.

In both of these approaches, the electric components have been substituted directly for mechanical or hydraulic units on a functional basis. The resulting vehicle yields substantial improvement in performance and maneuverability over equal capacity units with other drive systems. In order to maximize the advantages of any type of vehicle, it is desirable to minimize deadweight so that cost of tires, fuel consumed, operator's time—the total fixed and variable charges of haulage—may be distributed over more payload tons per cycle.

Electric motors must have frames of material with desirable magnetic properties and sufficient cross section to form a path of low magnetic resistance. These frames are conventionally made of steel, and the resulting cross section is adequate for carrying large mechanical loads as well as providing the required magnetic path.

From this concept came the "Motorized Wheel" which utilizes the motor magnet frame as the load-carrying member of the vehicle. Briefly, the motor frame is a large cylinder flanged on the inboard end to form a bolting surface for attachment to the vehicle, as shown. Within the frame is a DC, series, traction-type motor. The field coils are stationary and are bolted to the cylinder. The armature, designed

and built to traction standards, rotates on its own bearings. The removable hub cap on the outboard end provides access to the commutator and caliper type disc brake. The latter provides 15,000 lb braking effort per wheel and is used for parking, spotting and auxiliary brake functions. The inboard end of the armature shaft is furnished with an internal spline. This spline drives the "sun" pinion, which is free to move radially, and engages three "planet" gears whose shafts are supported in fixed position. These high-speed planet gears drive low-speed gears cut on the same shafts which engage an internal ring gear for the final reduction. Engagement of the ring gear and the wheel is through a spline. The terms "sun" and "planet" gears have been used in this description, since they appear to be a planetary-like system, but the planet gear bearings prevent the gears from revolving around the pinion, therefore the gear train is not truly "planetary."

The Motorized Wheel was designed to drive rubber tired vehicles of any configuration in the over-500-engine-horsepower class using tires with 29- to 45-in rim diameters or with load capacity up to some 75,000 lb per vehicle wheel. At present representative vehicles using this new drive are either undergoing test; in process of construction; or on the drawing boards of various vehicle builders. A 55-ton capacity unit, equipped with four Motorized Wheels and using 37.5x33 tires, is shown in an accompanying illustration. Built by Unit Rig & Equipment Co., Tulsa, Okla., this vehicle is in iron mining service in Minnesota.

Electric drive works from either engine-driven generators or from overhead electric systems for "straight-electric" vehicles. In engine-power applications, high-speed diesel engines rated in excess of 600-hp provide performance and mainteance characteristics superior to that obtainable with installations of multiple small-capacity, low-horsepower engines using other available power transmissions. The advent of reliable higher horsepower, lightweight diesel engines and the intensified development on industrial gas turbine engines of comparable horsepower and cost promise further increases in the performance of the engine-powered vehicles by giving them even more favorable horsepower-per-ton ratios.

At present, the limiting parameter on engine-powered vehicles is the capability of the engine. A 4-wheel drive vehicle, for instance, is capable of delivering over 1,500 rim horsepower. Full utilization of the drive within its torque and speed capabilities would require total installed engine capacity, including nominal auxillary loads for radiator fans, steering, etc., of about 1,800 hp. To make use of this inherent feature in electric drive, users have installed 2-wire overhead contact systems to furnish power for straight-electric vehicles operating in much the same way as the familiar trackless trolley coaches in many large cities.

This type of electrification has been successfully employed by a southern California operator using "trolley trucks" of about 30 tons capacity, as shown. In this early application a single traction motor of the type used in diesel-electric locomotives turns the propeller shaft of an otherwise conventional drive train.

In descending grades in the underground operation, braking is accomplished electrically by dissipating the kinetic energy as heat in the accelerating resistors. The traction motor, now connected as a generator, is driven by the vehicle and loaded on the resistor. This type braking, available in engine-driven vehicles as well as in trolley types, provides extremely high braking rates without danger of fade. There are no high maintenance charges for inspection, adjustment and replacement of friction surfaces for braking duty.

Electrification has attracted widespread attention because of the ability of its high-horsepower-per-ton vehicle to out-perform conventional diesel trucks and because of the low total operating cost reported thus far. In discussing the application referred to above, a mine official recently stated:

"The first cost of the electric truck is considerably higher than that of the diesel. However, because of the increased production on the long (4,400 foot) haul, the direct operating labor cost is less.

"Certain unforeseen benefits have appeared by switching to electric trucks for our main haulage. Tire wear and ability to maintain traction on muddy roads are the main advantage in this group. Lower maintenance costs, primarily because there are no brake, gear or clutch problems are also advantages in favor of electric trucks."

Electrification, in general, offers generous advantages to the user faced with lifting large amounts of material out of a pit. Available diesel-powered vehicles are limited to relatively low grades. Where road and weather conditions permit operation at 20% adhesion, electrified haulage systems can move material up 15% haul-road grades at about 13 mph with 60-lb per ton rolling resistance. A pit now designed with 6% grades can reduce its haul distance on the grade to less than half by electrifying the haul and increasing the grade to 12-15%, with resultant faster cycle time and increased hourly production for less total cost per hour. Steeper grades also can result in a steeper sided cone for the mine profile, reducing the total material that must be moved to get at the ore body. High power engine-type vehicles can yield the same gradability, but their operating cost on long, steep-grade hauls becomes excessive. At the lower lifts, such as encountered in coal operations, the diesel-electric vehicle provides the optimum haulage medium; but as the lift increases the trolley vehicles show increasing operating cost advantage.

The advantage of the diesel- electric vehicle over the smaller and lower-horsepower per-ton diesel-torque converter unit lies principally in the savings in labor costs, drive train and brake maintenance, plus the higher efficiency of electric drive (80-85%) vs the 70% average for typical hydraulic torque-converter systems.

Although each element of the electric drive systems—either trolley- or engine-powered—has been the object of intensive separate study and development, the full scale application of vehicles loading electric drive to its maximum torque, speed, horsepower and static load capabilities is just now beginning on a multiple trial basis. The coordinated combination of these components creates systems of unusual capabilities which, understandably, the industry will want to see to believe.

Vehicles of each type described above are now appearing in the metal mining scene. They will afford the coal miner the opportunity to witness the ability of both the engine and trolley-powered electric drives to provide reliable, high performance low cost haulage.

Exploration Expense

The present situation taxwise
What the coal approach should be
Cases in point

Donald M. Gamet and **Marshall F. Faillace,** Arthur Andersen & Co., Kansas City, Mo.

MINE EXPLORATION EXPENSE is primarily a concept created by Sec. 23 (ff) of the Internal Revenue Code of 1939, added by the Revenue Act of 1951, and by its counterpart, Sec. 615 of the Internal Revenue Code of 1954. Prior to 1951, exploration costs were considered together with development costs, the total of both incurred prior to the production stage being capital expenditures added to the depletable basis of the mineral property.[1] No attempt was made by the courts or by the then Bureau of Internal Revenue to separate these two elements of the cost of developing a mine to the producing stage.[1]

It is also significant that industry practice lumped both functions into one category—development costs—and is, therefore, of no assistance in making the separation now required by the statute. In fact, the action of Congress in establishing the two separate categories was contrary to recommendations made by mining industry representatives.[2]

Despite this, when the separate concept of "exploration expense" was introduced into the Revenue Act of 1951 by the Senate Finance Committee, it was defined in very general terms[3] which are of little help in determining the end of the exploration stage and the beginning of the development stage.

The reference in the Senate Finance Committee report to "existing law" is confusing in view of the irrelevance of the distinction prior to the passage of the Revenue Act of 1951.

Since the problem bears some similarity to the circumstances giving rise to discovery depletion, it may be that Congress was referring to the regulations and court decisions dealing with that subject. In any event, it seems clear that the Internal Revenue Service intends to relate the two questions. The regulations dealing with the determination of the end of the exploration stage[4] contain wording similar to that prescribing the now obsolete "discovery test."[4] Certain of the court cases[5] dealing with discovery depletion are quite helpful in resolving questions relating to exploration expenditures. However, it should be noted that the discovery test is the time at which ". . . there is disclosed . . . a mineral deposit . . . which in either case exists in quantity and grades sufficient to justify commercial exploitation." This wording clearly implies that knowledge of the quality of the deposit was an essential part of the discovery. In the statutory provisions[6] this reference to "grades" is not made. Despite the wording of the regulations (Note 4), this is ground for considerable doubt as to whether the exploration test is intended to parallel the now obsolete discovery test.

Alexander and Grant, in *Tax Law Review*,[7] state:

"Exploration expenditures include geological and geophysical investigations, reconnaissance, surveying, test-pitting, trenching, drilling, cross-cutting, and all others incurred in ascertaining the existence, position, or extent of a mineral or ore deposit."

In *Rialto Mining Corp.*[5] the court made findings of fact that would include as exploration expenses prospecting, drifting, sinking a shaft, cross-cutting and pumping, all incurred before the discovery of ore in commercial quantities.

The Internal Revenue Code attempts no more precise definition than that given in the Senate Finance Committee report (Note 3). The regulations on Sec. 615 and 616, IRC 1954, and the regulations under prior law[8] merely paraphrase the law.

In the light of this background, it should not be surprising that the rules which establish the boundaries of exploration expenses and which govern the limitations upon their deductibility often seem arbitrary and that their application in varied situations appear capricious. Since the concept of exploration expense has no counterpart in industry practice, it can be little else than technical. In many instances the securing of tax benefit for such expenses will be solely dependent upon these technicalities.

However, as a practical matter, it is probable that the availability of evidence to support the contention that a mine has passed the exploration stage will be more important than the precise determination of that point by the developer. In most cases, the most effective evidence will be the actual development of the mine. Accordingly, it is extremely important that the decision of the responsible persons to construct a new mine be recorded at the earliest practicable time, together with the exploration data on which the conclusion is based.

This decision need not await and, in fact, should not await the resolving of the many questions relating to quality, mining conditions and available market, but may be made subject to these factors (see Case No. 2). It seems virtually certain that the developer who builds a careful record to support this conclusion will be able to establish a much earlier line between exploration and development than the one who fails in this regard. By so doing, he will escape much of the adverse effect of the limitations on exploration expense.[9]

No court decisions have been rendered treating this question as relating to taxable years after 1950. However, the dividing line between exploration expense and development expense will in many cases determine whether a given expenditure is deductible for tax purposes or lost entirely through the effect of percentage depletion on the depletable base. After enough years have passed to

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1. GCM 13954, CB XIII-2, 66 (1934); Guanacevi Mining Co. v. Comm'r, 127 F (2d) 49, 29 AFTR 66; Reg. 111, Sec. 29.23 (m)-15(a); Little Cahaba Coal Co., et al. v. U.S., 15 F (2d), 863, 6 AFTR 6387; Connellsville Central Coke Co. v. Comm'r, 27 BTA 771.
2. Hearings before Senate Finance Committee on HR 4473, 82d Cong., 1st sess., 1174 et. seq. (1951) (Henry B. Fernald for American Mining Congress).
3. Sen. Rep. No. 781, Pt. 2, 82d Cong., 1st sess., 64 (1951), CB 1951-2, 589: "The determination of the beginning of the development stage is to be made, as under existing law, by reference to the time when the existence of ores or minerals in commercially marketable quantities is disclosed."
4. Reg. 111, Sec. 29.23 (m)-14(b); Reg. 1.615-1(a).
5. Alamo Coal Co., 31 BTA 869, 877; Rialto Mining Corp., 25 BTA 980, 985; U. S. Potash, Inc., P-H BTA Mem. Dec., Par. 41,393; Clarence P. Sidwell, 11 TC 826.
6. IRC (1939), Sec. 23(ff); IRC (1954), Sec. 615.
7. "Mine Development and Exploration Expenditures", 8 *Tax Law Review*, 401, 411 (1953).
8. Reg. 118, Sec. 39.23(ff)-1 and (cc)-1.
9. IRC (1954), Sec. 615(c).

exhaust the overall limitations relating to these expenditures for a substantial number of taxpayers extensive litigation seems inevitable. The body of judicial interpretation which develops may have profound influence on the conclusions reached in the cases in this section.

Exploration Cases

1. General Definition—A owns land on which outcroppings indicate coal. During the taxable year geologists are hired to determine the likelihood of deposits and probable location. After the report was received, the corporation moved a drill and crew from an operating mine and drilled a substantial number of test holes. Moving cost, wages and operating costs totalled $15,000 during this period and depreciation was $1,500. After drilling results were mapped, a small test-slope was sunk to gain further data on seam extent, coal quality, mining conditions, etc.

At the end of the year a conclusion had not yet been reached as to whether there was enough coal for a mine and if so if it could be mined profitably. Before filing its tax return for the calendar year the corporation must determine whether these various expenses are deductible—assuming that it has not exceeded its overall limit on exploration expenses and does not have over $100,000 of such expenses during the year.

All the expenses are included in exploration and the corporation may either deduct as ordinary and necessary or elect to defer and write them off over the life of the mineral benefitted if it proves to be a commercially mineable deposit.[1] This includes depreciation on the equipment used, but not any property purchase money, which itself is subject to the depreciation allowance.[2]

1. IRC (1954), Sec. 615; Reg., Sec. 1.615.
2. IRC (1954), Sec. 615(a); Reg., Sec. 1.615-1(b) (2).

2. Quality Tests to Determine Commercial Marketability—A owns or leases coal in a mountainous area. It has been drilled and its extent and relationship to the surface is generally known. Drill samples indicated low-volatile metallurgical coal. If confirmed, the seam would be commercially mineable; if not, high cost and a long haul to market would make mining impracticable. A definite answer can be obtained only by an actual volume test by the steel mill, necessitating a $50,000 rock slope. The corporation already had reached its Sec. 615 limitation on exploration costs.

If the cost of the rock slope is exploration expense it must be capitalized as part of the depletable base;[1] if development, it can be deducted as expense.[2]

This is a close question and there is no direct authority on which to base a decision. However there is a close analogy with the determination required for discovery depletion under prior law. *Alamo Coal*[3] the point of discovery, corresponding generally to the end of the exploration stage, was described as follows:

"We are convinced that the discovery of the mine, as contemplated by the statue, refers not to the finding of a mine in the sense of a complete operating unit, but the ascertainment of a natural deposit of coal or mineral previously unknown."

The court further pointed out that the discovery date was before all the characteristics of the deposit and mining conditions became known.

In *U.S. Potash*[4], after similar comment, the court concluded:

"In our opinion the evidence clearly shows that on Sept. 23, 1930, a discovery was made of a potash or sylvite deposit in 'quantity and grades sufficient to justify commercial exploitation'".

The language of Senate Finance Committee report dealing with the distinction between exploration and development supports this view[5]:

"The determination of the beginning of the development stage is to be made, as under existing law, by reference to the time when the *existence* of ores or minerals in commercially marketable *quantities* is disclosed" (emphasis supplied).

Although the regulations[6] bring quality in, they relate it to all the circumstances, including the action of the taxpayer, rather than the specific quality tests. This appears to recognize that all questions of quality, marketability, etc., need not be answered by the time development is begun if there is reason to believe that a commercial deposit has been located and subsequent events prove this to be true. This also is supported by informal IRS ruling[7], in part as follows:

"Exploration Costs—This may be defined as all the costs which aid in determining existence, the size, and extent of the deposit or ore body . . ."

Accordingly, if the test shows acceptable metallurgical coal, cost of the rock slope should be treated as development; if not, the cost probably can be recovered through abandonment.

1. IRC (1954), Sec. 615.
2. IRC (1954), Sec. 616.
3. 31 BTA 869, 877.
4. U.S. Potash Co., Inc., P-H BTA Mem. Dec., Par. 41,393 and 41,850.
5. Sen. rep. No. 781, Pt. 2, 82d Cong. 1st sess., 64 (1951) CB 1951-2, 589.
6. Reg. 118, Sec. 39.23(ff)-1(a) (1); Reg., Sec. 1.615-1(a) (1).
7. Memo of instructions issued by the Omaha region, 565 CCH, Par. 6398.

3. Exploration Expenditures After Start of Development Stage—A has an underground mine in full production in the No. 5 seam. When it was constructed only half the field under the company's control had been explored, but the reserves warranted development of the property. Present forecasts indicate a market for all the additional reserves, if any. Core drilling at a cost of $150,000 is undertaken to determine the full extent of the reserves. In addition to establishing the location and extent of the No. 5 coal, drilling also located another seam not previously known.

If the drilling was for tracing the No. 5 into the after-acquired property, and finding the other seam was simply a by-product, all the $150,000 of expense in the taxable year should be treated as development expense[1]. This is not entirely without question because of the way IRS has defined "mineral deposit" in the regulations[2] —i.e. a deposit could never exceed in extent the minerals in a single, separate interest of a single, separately acquired property.[3] If it followed this definition literally, IRS might contend that at least part of the drilling in the after-acquired and previously unexplored tracts was exploration.

Practically, however, it would usually appear that such things as general geology, overburden structure and outcroppings would have been determined when the additional tracts were acquired, and the fact that it was a continuous deposit, would be sufficient to indicate existence of a commercially mineable reserve.[4] Consequently, the properties would be in the development stage when acquired and never would be in the exploration stage.

If in addition to the drilling to define the No. 5 seam other drilling was done to determine the existence of other minerals, the costs would have to be treated as exploration expense, assuming that the additional seam was commercially mineable.[5]

1. IRC (1954), Sec. 616.
2. Reg., Sec. 1.611-1(d).
3. IRC (1954), Sec. 614 (a).
4. See Reg. 111, Sec. 29.23 (m)-(14) (d); Clarence P. Sidwell, 11 TC 826, 830.
5. IRC (1954), Sec. 615.

4. Exploration Expenditures on Existing Mine—For many years Corporation A had mined No. 5 coal by a deep shaft. Market conditions and rising cost resulted in closing in 1950, but in 1957 improved markets and the possible reduced operating costs provided by new equipment and methods led to reconsideration of the mine status. An extensive survey, including test borings, was undertaken to determine whether to open a new slope property. Expenditures were $50,000 and the decision was to open the mine.

If maps from the previous operation had not been retained, or if the company believed these to be unreliable, making it necessary to make these expenditures to determine the extent of the deposit, the $50,000 becomes exploration expense subject to statutory limitations.[1] If the feasibility of a new slope and effective use of modern equipment were the aims, the outlay becomes development expense.

The line is thin but its determination frequently will mean the difference between deducting the expenditures for tax purposes or being required to capitalize them, thus risking their loss entirely for tax purposes because of the effect of percentage depletion.

The existence of a previous mine affects this question indirectly since the statutory provisions concerning exploration expense relate to a deposit[2], rather than a mine. However, it makes it probable that enough is known about the deposit to cause anything connected with the new opening to be classed immediately as part of the development stage, rather than exploration.[3]

However, if existence of a specific deposit is not known, or if it is not known whether it is commercially mineable, expenditures for obtaining this information are exploration expenses regardless of mining operations, past or present, on the property or in the vicinity.[3]

1. Guanacevi Mining Co. v. Comm'r., 127 F (2d) 49, 29 AFTR 66.
2. IRC (1954), Sec. 615(a).
3. Reg. 111, Sec. 29.23 (m)-14(d).

5. Gross Income During Exploration Operations—In expending $110,000 in extensive exploration of an undeveloped lease, A removed a sizable quantity of coal from the outcrops for sampling purposes, which was sold for $15,000.

IRS has ruled that in such situations, only the excess of expenditures over receipts derived from incidental coal sales is exploration expenditure subject to the statutory limitations.[1] Although there is no statutory reference to such offsetting, and the regulations do not deal with the question, the Senate Finance Committee report, when these provisions were added to the 1951 Revenue Act[2], states that they are applicable only to expenditures that would not have been deductible except for this subsection (Sec. 23(ff) IRC 1939). Under the law then in effect, expenditures before the production stage, including both exploration and development, in excess of income produced by these expenditures, had to be capitalized as part of the depletable base of the mineral property.[3] Accordingly, it apparently is only this excess which is involved in Sec. 615 and 616, IRC 1954.

This question is only important in the event of an election to defer or after the limitation on exploration expenditures has been exhausted. The portion of such expenditures not in excess of such income is always fully deductible.[4] Also, this "netting process" has no application to determining "gross income from the property" for percentage depletion.

1. Rev. rul. 55-430, CB 1955-2, 276.
8. Sen. rep. No. 781, Pt. 2, 82d Cong., 1st sess. 64 (1951); CB 1951-2, 589.
3. GCM 13954, CB XIII-2, 66, p 69; Morrisdale Coal Co. v. Comm'r 97, F (2d) 272, 21 AFTR 349.
4. Reg. 118, Sec. 39.23(cc)-1(b) (1).

6. Prospecting Prior to Acquisition of Interest—A enters lands of B to survey to determine if core drilling for coal deposits would be warranted, expending $2,000. At time of permission to enter no option or other acquisition arrangements were made. The original survey was in 1957 and A had not previously incurred exploration expenditures. In July, 1958, he concludes that indications of a coal deposit warrant further investigation. He options the mineral rights from B and, after successful test drilling, exercises the option before Dec. 31, 1958.

The language of the IRC appears to be broad enough to let A deduct or defer exploration expenditures of $2,000 in 1957.[1] However, IRS apparently would consider the expenditure part of the cost of a lease, if taken.[2] The service appears to be in error in this respect. It uses as authority I.T. 4006[3], which summarizes a number of cases involving oil, gas and solid minerals and concludes that in all cases where commercially mineable minerals are found exploration expenses are capital items regardless of whether or not the taxpayer owned the property. Since the date of that I.T., the Revenue Act of 1951 made exploration expenses relating to solid minerals deductible, subject to certain limitations. Thus I.T. 4006 is inapplicable to minerals other than oil and gas.

Further, in *Rialto Mining*,[4] one of the cases cited in I.T. 4006, exploration on mining properties owned and under option were treated without distinction and held to be part of the depletable base under the then-applicable law. It seems clear that all Rialto-type exploration expenses would now be treated under Sec. 615, IRC 1954.

1. See Joint Committee Staff summary of provisions of Revenue Act of 1951, CB 1951-2, 319; Senate rep. No. 781 concerning the Revenue Act of 1951, CB 1951-2, 503, Supp. Rep., Senate Committee, discussion of the technical provisions of the Revenue Act of 1951, CB 1951-2, 589.
2. Memo of instructions issued by Omaha region, 565 CCH, Par. 6398.
3. CB 1950-1, 48
4. 25 BTA 980.

7. Exploration in Return for Partial Interest—B, who has not incurred previous exploration expenditures, spends $20,000 to explore lease held by A, getting one-eighth working interest in return.

Under the provisions of the regulations[1] B would be entitled to a deduction for $2,500 (⅛) and would be required to capitalize $17,500 as the cost of his interest in the lease. To this extent, this is similar to the treatment accorded intangible drilling and development costs on oil and gas properties.[2]

The receipt of the working interest would probably not result in income taxable to B as compensation for services rendered. However, the announced position of the service in this matter relates to matters arising in the oil and gas industry,[3] and may not be extended to other minerals.

1. Reg., Sec. 1.615-1(b) (3).
2. Reg. 118, Sec. 39.23(m)-16(a) (1) and Reg., Sec. 1.612-4(a) (1).
3. GCM 22730, CB 1941-1, 214 (at pp 221-222).

8. Overall Limitation: Option to Capitalize Rather Than Expense or Defer—Organized in June, 1956, to acquire, explore and develop strip coal mines, Corporation A in the remainder of 1956 acquired a number of leases in promising areas. It adopted the calendar year for accounting and tax returns. As part of its long-term program it spent $2,000 on exploring leases prior to Dec. 31, 1956. Total 5-yr exploration budget was $1,000,000, and outlay in each year is expected to be more than $100,000.

Under the circumstances it would appear prudent to capitalize the $2,000 spent in 1956 as part of the depletable base and thus avoid using one of the four years of the limitation period. IRS has construed exploration expenditure provisions to provide for a 3-way option: deduct, defer and amortize, or capitalize.[1]

If A, however, failed to capitalize the $2,000 laid out in 1956, and in some year or years after July 6, 1960, again made exploration expenditures, it then could could elect to defer or amortize an additional $98,000. At this point it will then have exhausted the $400,000 composite limitation applicable to the years after July 6, 1960,[2] and thereafter will be required to capitalize exploration expenses as depletable basis of its mineral properties.

1. Reg., Sec. 1.615-1(a); Rev. rul. 58-358, CB 1958-2, 359.
2. IRC (1954), Sec. 615(a), as amended by PL 86-594.

9. Exploration Expenditures on More Than One Deposit: Right of Selection—A can elect to defer or deduct 1957 exploration expenditures. It spent as follows:

Deposit 1, $60,000.
Deposit 2, $70,000.
Deposit 3, $25,000.

In 1958, before filing its 1957 return, work on No. 3 was completed, with the conclusion that it was not worth development. The leases were dropped.

Stripping was begun on No. 1, and prior to filing the 1957 return it was concluded the production cost would be so high that even though the operation would be profitable, depletion would be limited to 50% of net income.

As to Deposit 2, it was concluded that it showed promise, though further development was postponed at least 5 yr. Mineral rights meantime would be retained.

Since the limit on 1957 expenditures to either expense and claim as deduction or defer and amortize, is only $100,000, a selection must be made as to which are to be deducted, deferred or capitalized as part of the depletable base.[1] This selection may be made on any part of the expenditures on any property.[2] Under the circumstances the best course is as follows:

Deposit 1—Deduct the entire $60,000 as 1957 expense, since deferring and amortizing would result in percentage-depletion limitations cutting the tax benefit from amortization in half, and this would probably also bar any benefit from capitalizing as depletable base.

Deposit 2—Claim the $40,000 remainder of the $100,000 allowable deduction as a 1957 deduction, adding the remaining $30,000 to the depletable base of the property. Since there is always the possibility of future abandonment, addition to depletable base here rather than on Deposit 1 is preferable.

Deposit 3—Capitalize the $25,000 as depletable base and recover in 1958 as a deduction for abandonment loss.

1. IRC (1954), Sec. 615; Reg., Sec. 1.615-1(a).
2. Reg., Sec. 1.615-2(a) (1).

10. Exploration Expenditures, Consolidated Returns: Effect on Dollar Limitation—Corporation P and three subsidiaries, all eligible to deduct or defer exploration expenditures in 1957, elect to file a consolidated return. They had incurred expenditures as follows:

Corporation P	$120,000
Corporation A	40,000
Corporation B	60,000
Corporation C	20,000

If total expenditures had been less than $100,000 they could have been claimed as made. Since they were in excess apportion-

ment is necessary.[1] If the subsidiaries consent in writing, the parent can make the apportionment as it sees fit.[2] Otherwise, the $100,000 must be allocated in proportion to the total of $240,000,[3] as follows:

Corporation P, 50%	$50,000.00
Corporation A, 16⅔%	16,667.67
Corporation B, 25%	25,000.00
Corporation C, 8½%	8,333.33

1. Consolidated returns reg., Sec. 1.1502-31(b) 12).
2. Consolidated returns reg., Sec. 1.1502-31(b) (12) (i) (b).
3. Consolidated returns reg., Sec. 1.1502-31(b) (12) (i) (a).
Note: Similar provisions existed under IRC of 1939, Reg. 129, Sec. 24-31(b) (30).

12. Consolidated Returns: Effect on Overall Limitation—Corporation B and its wholly owned subsidiary elected to file a consolidated return for calendar 1957. B had $400,000 in calendar 1953, 1954, 1955, and deducted mine-exploration expenses of 1956, and therefore is not entitled to deduct or defer and amortize such expenses after 1956. In 1957, A incurred such expenditures the first time. It also was its first year to file a consolidated return.

Under the circumstances, A may not deduct or elect to defer and amortize mine exploration expenditures in 1957. When one member of an affiliated group has exhausted its limitation the limitation will apply to the entire group so that all exploration expenses incurred by any group member must then be capitalized as part of the depletable base of the respective deposits involved.[1]

If A files separate returns in subsequent years, however, it will not be considered as having used in 1957 any of its four limitation years.[2]

Although the consolidated regulations have not been changed to reflect the change in the limitation from 4 yr to $400,000 for the years beginning after July 6, 1960[3], the principles are the same, and there is every reason to believe that the same result will be reached in years subject to the dollar-amount limitation.

1. Consolidated-returns reg., Sec. 1.1502(b) (12) (ii).
2. IRC (1954), Sec. 615(c).
3. PL 86-594.

12. Consolidated Returns: Effect on the Overall Limitation—For calendar 1954, Corporation P and wholly owned subsidiary, A, joined in a consolidated return. P had exploration expenditures of $100,000 in 1954; A, none in 1954 or any prior year. P's expenses were deducted in the consolidated return.

P sold all the stock of A Jan. 1, 1955. In 1955, 1956 and 1957, A spent and deducted $100,000 each year. A again incurred exploration expenditures in 1958.

A must capitalize as depletable costs the 1958 expenditures. If an affiliated group filing a consolidated return has been allowed an exploration deduction, each member of the group, regardless of its situation also is deemed to have incurred such expenditures when it comes to applying the limitation.[1]

The consolidated regulations have not yet been amended to reflect the change in the limitation on exploration expenditures to a composite dollar amount.[2] However, this amendment to Sec. 615 applicable to the years beginning after July 6, 1960, does not change the principles involved in this case. Accordingly it seems reasonable to expect that the same result can be expected in years subject to the composite dollar limitation.

1. Consolidated-returns reg., Sec. 1-1502-45; Reg. 129, IRC (1939), Sec. 24.45
2. PL 86-594

13. Expenditures on Deposits Later Abandoned—Corporation A, no exploration expenditures before 1957, reports income and files returns on a calendar-year basis. Exploration expenses of $50,000 were incurred in 1957. However, no mineable deposits were found and the leases were dropped in November, 1957.

A has not used any of the $400,000 overall limitation. The provisions of the IRC dealing with exploration expenditures apply only to those not otherwise deductible.[1] In this instance, the expenditures are deductible as abandonments.[2]

1. IRC (1954), Sec. 615(a); Reg., Sec. 1.615-1(b) (1).
2. IRC (1954), Sec. 165.

14. Overall Limitation — Acquisition of Mineral Property in a Tax-Free Transaction—Filing on a calendar-year basis, Corporation A claimed and was allowed exploration expenditures, since Dec. 31, 1950, of $25,000 in 1954 and $75,000 in 1957.

B, also on a calendar-year basis, similarly incurred expenditures of $40,000 in 1955 and 1956. It deducted for 1955 and elected to defer 1956.

The corporations merged Jan. 31, 1958, in a nontaxable transaction. At that time B owned and operated the mine for which 1956 expenditures were deferred. A acquired the mine in the merger.

Corporation A will be entitled to claim a deduction for amortization expenditures for the mine acquired from B—computed in the same manner and for the same amount as if still held by B.[1] A will not be permitted to deduct or treat as deferred expense any exploration costs incurred in 1958 or any year beginning prior to July 6, 1960, because it had incurred such expenditures in two years subsequent to Dec. 31, 1950, and had acquired a corporation in similar circumstances, making a total of four preceding years of deduction or deferment of such expenses.[2]

If in A's first taxable year or years after July 6, 1960, it again incurs exploration expenditures it will be entitled to deduct or defer an additional total of $220,000. Then it will have exhausted in limitation for the years beginning after July 6, 1960[3], and will be required to capitalize into the depletable basis of its mineral properties.

When a taxpayer acquires any mineral property in a nontaxable transaction, with the transferor's basis carrying over to the new owner, such new owner is charged with that portion of the limitation utilized previously by the transferor.

1. IRC (1954), Sec., 381(c) (10); see also Case 22.
2. IRC (1954), Sec. 615(c); reg., Sec. 1.615-4(b) (ii).
3. IRC (1954), Sec. 615(c) as amended by PL 86-594.

15. Overall Limitation — Acquisition of Mineral Property in a Tax-Free Transaction—Corporation A, calendar-year basis, has incurred exploration expenditures since Dec. 31, 1950, of $100,000 in 1954 and 1957. B, also calendar-year basis, also incurred $100,000 in 1954 and 1957, and elected to defer 1954 and deduct 1957.

On Jan. 31, 1958, B was merged into A in a nontaxable transaction. At the time, B owned and operated the mine for which 1954 expenses had been deferred. A took it over.

Here, as in the preceding case, A will be entitled to claim a deduction for the amortization expenditures on the mine taken over from B. Although there is some question as to whether A can use Sec. 615 with respect to exploration expenditures in 1958 or later years beginning before July 6, 1960, it appears that A should still have two of the 4-yr limitation despite merger with B. The wording of the statutory limitation[1] is in part as follows:

"This section shall not apply to any amount paid or incurred in any taxable year if in any four preceding years a deduction or election under this section, or the corresponding provision of prior laws, has been allowed to, or exercised by (1) the taxpayer, or (2) the individual or corporation who has transferred to the taxpayer any mineral property."

This is much the same as the predecessor section of the 1939 Code.[2] Substantially similar wording is used in the Senate Committee report relating to enactment of the predecessor code as part of the Revenue Act of 1951.[3] Although it seems clear that four preceding years, rather than preceding elections, are involved, the IRS has attempted to limit to four elections in regulations adopted under the 1939 Code.[4] The wording in 1954 Code regulations is not as clear[5], but would appear to provide the same limiting interpretation.

The provisions of the regulations seem on their face to be contrary to the statutory terminology. Additional evidence that Congress did not intend what is proposed by the IRS is provided in Congressional-committee reports relating to Sec. 381(c)(10) of the 1954 Code.[6] In those reports it is noted that although the acquiring corporation is charged with prior elections made by the transferor, if more than one such transferor make the election with respect to exploration expenses in one taxable year, only one year is to be included in the total of the acquiring corporation.

For years beginning after July 6, 1960, A will be required to capitalize as part of the depletable basis of the affected properties all exploration expenditures regardless of action in the intervening years since 1957. Under the amendment to Sec. 615 made in PL 86-594, it is clear that acquiring corporation will have attributed to it the action previously taken by the acquired corporation.

1. IRC (1954), Sec. 615(c).
2. IRC (1939), Sec. 23(ff) (3).
3. Sen. Rep. No. 781, Pt. 2, 82d Cong., 1st sess. 64 (1951), CB 1951-2, 589.
4. Reg. 118, Sec. 39.23(ff)-1(c).
5. Reg., Sec. 1.615-4.
6. Sen. Rep. No. 1622, 83d Cong., 2d sess. 282, House of Repr. No. 1337, 83d Cong., 2d sess. A 140.

16. Overall Limitation — Exchange of

Mineral Properties for Stock of Controlled Corporation—A is organized by individuals X and Y and is authorized to issue only one class of common stock. X assigns his interest in certain mineral properties having a value of $100,000 to the corporation for 50% of the stock to be issued. Y assigns a dragline valued at $100,000 for the remaining stock. In 1956 and 1957 X incurred exploration expenditures of $100,000 attributable to properties other than those transferred, and elected to defer. Y had incurred and deducted exploration expenses of $100,000 in 1954 and 1955.

For taxable years after 1957 and beginning before July 6, 1960, A has only two years to claim exploration expenses as a deduction or defer. The years X incurred deductible or deferrable expenses are counted against A's four years for the years beginning before July 6, 1960. However, because Y did not transfer mineral properties, the years he used Sec. 615 are not counted against A.[1]

If A incurs expenditures in any year or years beginning subsequent to July 6, 1960, it may deduct or elect to defer and amortize expenditures equal to $200,000 minus the amount deducted or deferred for years after 1957 and beginning prior to July 6, 1960. For years beginning after July 6, 1960, the overall limitation is a composite dollar amount of $400,000 rather than four years. In applying the composite dollar limitation, however, A would continue to be charged with the action of X with respect to 1956 and 1957 expenditures.[2]

1. IRC (1954), Sec. 615(c); Reg., Sec. 1.615-4(b) (1).
2. IRC (1954), Sec. 615(c), as amended by PL 86-594.

17. Overall Limitation—Asset Acquisition in Reorganization Where No Mineral Properties Are Transferred—Corporation A, calendar-year basis, has claimed and been allowed exploration expenditures of $100,000 in 1954 and 1955. Corporation B, also calendar-year, incurred expenditures of $100,000 in 1956 and 1957, and elected to defer 1956 and deduct 1957. A and B merged Jan. 31, 1958, in a nontaxable transaction. Late in 1957, B disposed of all its mineral properties, and was operating as a sales company Jan. 31. No mineral properties passed to A in the merger.

Corporation A wishes to know if it must capitalize as depletable exploration expenditures in 1958 and subsequent years.

There appears to be a conflict in the statutes and the answer to this question therefore is in doubt. Sec. 381(c)(10), Code of 1954, appears to charge A with action taken by B in previous years whether or not it receives mineral properties from B. Sec. 615(c), on the other hand, appears to contemplate this only if mineral properties were transferred by B. Sec. 615(c) appears to limit application of Sec. 381(c)(10) in determining the 4-yr limitation to those instances of actual transfer of mineral properties. This limitation would of course, resolve the conflict. The regulations[1], however, seem to impose both limitations and thus compound the conflict of authority.

The reports of both House and Senate committees at the time Sec. 381(c)(10) was being considered[2] indicate that Congress did not intend to create an inconsistency between this section and Sec. 615(c). Unfortunately, the wording actually adopted does not carry out the indicated intention.

Since the subject of Sec. 381(c)(10) is treatment by the acquiring corporation of exploration expenditures previously deferred by the corporation acquired, and in view of the inconsistency between the section as written and Congressional intent, the provisions of the section should be limited to instances when this is the single issue. In all other situation, Sec. 615(c) should be held to be controlling. A therefore should be entitled to use Sec. 615 in two additional years after 1957 and beginning before July 6, 1960, and to the extent of $200,000 minus the amount deducted or deferred in previous years since 1957 in taxable years beginning after July 6, 1960.[3]

1. Reg., Sec. 1.615-4(b) (1) (ii).
2. House Rept. No. 1337, 83d Cong., 2d sess., Sec. 381(c) (10); Sen. Rept. No. 1622, same session and section.
3. IRC (1954), Sec. 615(c), as amended by PL 86-594.

18. Overall Limitation — Tax-Free Exchange, Only Oil Properties Transferred—Individual X organized Corporation A in 1956, authorized to issue only common stock of one class. X assigned his interest in certain oil properties only to A for all the authorized stock. X had incurred and deducted exploration expenditures in 1954 and 1955. A's officers want to know if X's action will be attributed to A in applying the expenditures limitation.

The expenditures by X probably will be attributed to A under Sec. 615, though it is difficult to understand why Congress intended this result, which the wording of the statute leaves little room for avoiding. The attribution provision refers to transfers of "mineral property."[1] IRC does not define the term, and it also is not defined in the regulations as a single term though each part is defined separately.[2] However, it was defined in the regulations[3] at the time of passage of the Revenue Act of 1951, and had been for many years. As so defined it clearly included oil and gas deposits.

This result is unfortunate since the purpose of the attribution of years provision is to prevent circumvention of the overall limitation. Transfer of oil and gas properties obviously could not further such a purpose. However, we must conclude that Congress was aware of this definition and would have excluded oil and gas deposits if so intended.

1. IRC (1954), Sec. 615(c), as amended by PL 86-594.
2. Reg., Sec. 1.611-1(d) (1), (4) and (5).
3. Reg. 111, Sec. 29.23(m)-1(b), (c) and (d).

19. Overall Limitation — Acquisition of Mineral Property in Liquidation of Subsidiary Under Sec. 334(b)(2)—Corporation A purchased the stock of Corporation B in 1958. A incurred exploration expenditures of $100,000 in each of the years 1954, 1955 and 1956, which it deducted. B incurred exploration expenditures of $100,000 in 1957 which it elected to defer and amortize. B was liquidated in 1959 and its mineral property transferred to A, the basis being the cost to A of B's stock under Sec. 334(b)(2), IRC Code of 1954. The officers of A want the answers to two questions:

1. Can A continue to amortize the expenditures deferred by B as the mineral is produced?
2. In determining overall limitations on A in the future will the use of Sec. 615 by B in 1957 be attributed to A?

Corporation A probably will not be entitled to deduct the unamortized portion of the expenditures deferred by B in 1957. Statutory provisions relating to carryovers in certain corporation acquisitions cover directly.[1] However, by their terms, these provisions do not apply where the basis of the assets distributed is determined under Sec. 334(b)(2).[2]

Although A might have been permitted to amortize and deduct before Sec. 381 was enacted, it seems unlikely that those general considerations could now be used to avoid the statutory limitation.[3]

Re the second question, the statutory provisions seem broad enough to cause the use of Sec. 615 by Corporation B in 1957 to be attributed to A.[4] The regulations, however, limit the attribution to liquidation of a subsidiary where the subsidiary's property basis carries over to the parent.[5] Since the parent probably will be denied the right to deduct the unamortized portion of the previously deferred expenditures it seems only fair that in applying the overall limitation, the subsidiary's action should not be attributed to it.

On this basis the provisions of the regulations seem a proper exercise of discretion by the commissioner, and should be sustained.

1. IRC (1954), Sec. 381(c) (10).
2. IRC (1954), Sec. 381 (a) (1).
3. See also Case 23
4. IRC (1954), Sec. 615(c); Sec. 615(c) (3) (C) added by PL 86-594.
5. Reg., Sec. 1.615-4(b) (1) (iii) (a).

20. Overall Limitation — Partners and Partnerships—A and B, individuals or corporations, formed a partnership or joint venture to exploit minerals on certain properties of A, who had incurred and deducted exploration expenditures in 1954 and 1955. None had ever been incurred by B. The capital contribution by A was his mineral-property interest; by B, cash. Reporting on a calendar-year basis, the partnershp incurred exploration expenditures in 1956, 1957 and 1958. The partnership was dissolved in 1959, and the assets divided, B getting the mineral properties.

The regulations treat exploration expenditures incurred by partners or partnerships purely on an individual basis, ignoring the partnership as an entity.[1] Although the regulations have not been changed to reflect changes in Sec. 615(c) made by PL 86-594, the principles remain the same. Under the regulation the results would be:

1. A would be entitled to elect to expense or defer his share of exploration expenditures for 1956 and 1957, but would have to capitalize those in years after 1957 and beginning before July 6, 1960.[2] In years beginning after that date A could deduct or defer an additional amount equal to $400,000 less expenditures attributed to him in 1954-57, inclusive. Thereafter he would have to capitalize as part of depletable base.

2. B could elect to expense or defer his share of exploration expenditures for all three partnership years. If he had expenditures in 1959 or 1960 he could use Sec. 615 up to the yearly limit of $100,000. In the years beginning after July 6, 1960, he could use the section for additional exploration expenditures if the previous total attributed from the partnership plus his previous personal deductions or deferrals is less than $400,000.

The provisions of the regulations appear to conflict with the IRC in this respect.[3] If the partnership was recognized as a single entity, the probable result would be:

1. The partnership could elect to expense or defer for 1956 and 1957, capitalizing 1958 as a depletable cost.

2. Following dissolution, Partner B, because of this action, would be charged with his pro rata share of 1956 and 1957 expenditures.

3. Not receiving any mineral properties in the dissolution, Partner A would not have attributed to him any partnership use of Sec. 615.

Some of the conflict was removed by PL 86-594, which eliminated the reference to partnership provisions from Sec. 615(c). The position in the regulations was also further strengthened by a House Committee statement on PL 86-594 that "in the case of partnerships, exploration expenditures deductions are determined at the level of the partners rather than the partnership."[4]

Since this distinction in treatment will be extremely important where new partners have individually exhausted their four years' limitations, it seems probable that this conflict will be resolved in the courts. However, at this time, the Congressional action in PL 86-594, together with the legislative purpose indicated by the House Committee, makes it very probable that the position of the regulations will be sustained.

1. Reg., Sec. 1.615-4(b) (4) and (5), and Sec. 1-702-1(a) (8).
2. IRC (1954), Sec. 615(c) as amended by PL 86-594.
3. IRC (1954), Sec. 615(c) and Sec. 703(b).
4. 603 CCH, Standard Federal Tax Reporter, par. 3573.05, p 34,171.

21. Overall and Yearly Limitations—Partners and Partnership—A and B entered into a joint venture qualifying as a partnership for tax purposes to explore and develop certain mineral properties acquired. A has used all his four years' limitation on exploration expenditures. During 1957 the venture expended $150,000 which could be deducted or deferred and amortized. In the same year B expended $60,000 on nonventure properties. Profit and loss is distributed equally to the venturers.

Although it is clear that the venture must make an election concerning the $150,000, application of the limitations on deduction or deferral is not. The regulations[2] indicate that B's $75,000 share of the venture expense, plus his own $60,000, exceeds the $100,000 maximum subject to deduction or deferral, and therefore B will have to capitalize $35,000. Although the regulations are not explicit it also would appear that A also would not be entitled to any deduction for his $75,000 share.

Although these results reflect the present position of the IRS, there is a validity question[3], though at this point it seems that the regulations will prevail.

For years beginning after July 6, 1960, the overall limitations has been changed from four years to a composite $400,000.[4] If this were the situation after July 6, 1960, A might be entitled to deduct or defer a portion of the 1957 partnership expenditures if his previous total deducted or deferred did not exceed $400,000. The only change is in the mechanics of applying the overall limitations. The principles are unchanged.

1. IRC (1954), Sec. 703(b); Reg., Sec. 1.703-1(b) (1).
2. Reg., Sec. 1.702-1(a) (8) (i) and example at (iii).
3. Case 20; see also Mertens, "Law of Federal Income Taxation," Vol. IV, Chap. 24, par. 24.53(a), p 165.
4. IRC (1954), Sec. 615(c) as amended by PL 86-594.

22. Amortization of Deferred Charges—Corporation A, calendar-year, obtained Tracts 1 and 2, adjoining, by different leases in separate transactions from different grantors, and in 1957 explored on both tracts, mostly with A's own crew and equipment. Equipment usage and time were kept separate by properties, with charges on Tract 1 of $24,000; Tract 2, $21,000. Coal in commercially marketable quantities was indicated as follows:

Tract 1—No. 11 seam, strippable, 500,000 tons.
No. 5 seam, deep only, 1,000,000 tons.
Tract 2—No. 11, 600,000 tons.
No. 5, 1,500,000 tons.

Stripping of the No. 11 coal was decided on in 1957, but decision on a deep mine for No. 5 was deferred. In its 1957 return the corporation made a valid election to defer and amortize the entire $45,000. The engineering department appraised the value of No. 11 coal in place of 10c; No. 5, 1c per ton. In 1957, 100,000 tons of No. 11 was mined from Tract 1 and sold.

Exploration also showed that the No. 5 probably also extended under adjoining properties and, in 1958, properties estimated to contain 10,000,000 tons of No. 5 were acquired. The properties had been drilled by their former owners and the results made known to A. In 1958, after the 1957 return had been filed, a slope to recover No. 5 coal from all properties was decided on.

Although the unit to be used in determining if the particular expenditure may be classified as exploration is clearly a mineral deposit, it is not clear that the same deposit is to be used as the basis for the rate of amortization where the taxpayer elects to defer and amortize the expense. The statutory provisions and the Senate Committee reports merely state as follows: "but shall be deductible on a ratable basis as the units of produced ores or minerals discovered or explored by reason of such expenditures are sold."[1] No reference is made to mineral deposit in this regard in the statute.

It might, therefore, be inferred that the minerals-benefitted test is to be made without the restrictions inherent in the terms "mineral deposit" and "mineral property." There is no direct authority but wording in the regulations indicates that the IRS intends to restrict the term "minerals discovered or explored" to mean within the "mineral property" where the exploration was made.[2] If this was followed, the expenses would be amortized separately over each tract and allocated between seams, per this computation:

Tract No. 1	**Value**
No. 11 Coal— 500,000x10c . . .	$50,000
No. 5 coal—1,000,000x 1c . . .	10,000
Total	$60,000
Deferred Cost	
No. 11—50,000/60,000x$24,000 .	$20,000
No. 5—10,000/60,000x$24,000 .	4,000
Total	$24,000
Amortization per ton	
No. 11—$20,000+ 500,000 . . .	$ 0.040
No. 5—$ 4,000+1,000,000 . . .	0.040
Allowable amortization for 1957, 100,000 tons at $0.04 per ton . .	$ 4,000

The computations would be similar for Tract 2.

Since operating losses may now be carried over a period of five years, and are no longer to be reduced by a percentage-depletion adjustment, it seems probable that there will be very few instances in which it will be desirable to defer exploration expenses.

Amortization of deferred-development expenditures would be computed similarly.

1. IRC (1954), Sec. 615(b); IRC (1939), Sec. 23(cc) (2).
2. Reg., Sec. 1.616-1(c). Although this portion of the regulations concerns deferred development the wording of the statute is identical for deferred exploration.

23. Amortization of Expenditures Previously Deferred Acquired in Non-Taxable Exchanges—In 1959, Corporation A acquired mineral properties from B (statutory merger) and C (substantially all of properties of C exchanged solely for voting stock of A). Both exchanges were tax-free. B incurred exploration expenditures in 1953 and 1957 on properties which went to A, electing to defer in each year. C also had incurred expenditures on transferred properties, also electing to defer. After the acquisition, A opened mines on the two properties.

It seems clear that Corporation A will be entitled to amortize expenditures by C in 1956 and B in 1957 as the minerals are mined and sold. This deduction will be in addition to the allowable for depletion and will be allowable to A as it would have been to B or C.[1] The unamortized portion also will be taken into account in computing the adjusted basis of the mineral interests involved in determining gain or loss on sale or abandonment.[2]

With respect to expenditures by B and C prior to 1954, the answer is not so clear. Under IRC 1939 and 1954, exploration expenditures are treated as deferred expense and are not added to the basis of the property to determine cost depletion.[3] However, under the IRC of 1939 there were no statutory provisions specifically on treatment of deferred expenditures in a reorganization; also, no court decisions. But there are decisions on a similar item, unamortized bond discount, and an IRS ruling on unused pension-plan deduction. In these instances, where the identity of the acquired corpora-

tion carried through, as in a statutory merger or consolidation, the acquiring corporation was permitted to amortize the deferred charge at issue after reorganization.[4]

In a relatively recent decision the U. S. Court of Appeals, 1st Circuit, applied the same reasoning to a reorganization involving trading of stock for assets on the ground that no artificial distinction should be made among types of tax-free reorganizations where practically the effect is the same.[5] There was, however, no clear answer before 1954 and the enactment of Sec. 381(c)(10) of the IRC (1954).[6] The same uncertainty would apply to expenditures before 1954 and transferred in a tax-free transaction qualifying under Sec. 112(b)(5) of the IRC (1939).

1. IRC (1954), Sec. 381(c)(10).
2. IRC (1954), Secs. 362(b), 615(d).
3. IRC (1939), Sec. 23(ff)(4); IRC 1954. Sec. 615(d).
4. Helvering v. Metropolitan Edison Co., 306 U. S. 522, 22AFTR 307; American Gas & Electric Co., v. U.S., 17F Supp. 151, 18 AFTR 901, each dealing with unamortized bond discount; P.S. 62, carryover of unused pension-plan deductions under IRC (1939), Sec. 23 (p).
5. F. C. Donovan, Inc. v. U.S. 261 F (2d) 470, 2 AFTR 2d 6221.
6. The Senate Finance Committee does not indicate any uncertainty over this question under IRC (1939) (see Senate Rept. No. 1622, 83d Cong., 2d sess., p 282).

24. Amortization of Expenditures Previously Deferred Acquired in Non-Taxable Exchange—Total Amount Attributed to Acquirer Exceeds Overall Limitation—In 1959, A acquired from B, in a tax-free statutory merger, mineral properties. A had deducted exploration expenditures of $100,000 in 1954, 1955, 1956 and 1957. B had incurred $100,000 in 1958, deducting $25,000 and deferring to amortize over production $75,000. A received this property and began production immediately from the reserves benefitted by the deferred expenditures.

This problem is not covered directly by law or regulations, and no reference is to be found in Congressional Committee reports or ruling of the Treasury Dept. On available authority, opposite interpretations are possible. In regulations covering Sec. 615(c)[1] the following statement is made:

"In determining the number of years in which a taxpayer has availed himself of Sec. 615, a year for which he makes an election to defer exploration expenditures shall count as one year. Any subsequent taxable year in which such deferred expenditures are deducted shall not be taken into account as one of the four years."

This might be construed to mean that the limitation is significant only at the time the election is made and not any time later. But the last sentence of Sec. 381(c)(10) states:

"For the purpose of applying the limitation provided in Sec. 615, if, for any taxable year, the distributor or transferor corporation was allowed the deduction in Sec. 615(a) or made the election in Sec. 615(b), the acquiring corporation shall be deemed to have been allowed such deduction or to have made such election, as the case may be."

Read literally, this would mean that A would be deemed to have elected to defer the $75,000 incurred and deferred by B in 1958. If this had actually been true, the election would have been void because of A's exhaustion of its limitation, and thus would not be entitled to any amortization of the $75,000 in 1959 or any later year.

At this time it cannot be predicted which view, if either, will prevail in this situation. Until there is an authoritative answer, the taxpayer should avoid creating this set of circumstances.

The provisions of Sec. 381[2] providing that matters covered are to be taken into account by the acquiring corporation as of the close of the transfer day would appear to preclude any adjustment of A's taxable inceme for pre-transfer years because of such a situation.

1. Reg., Sec. 1.615-4(a).
2. IRC (1954), Sec. 381(a).

25. Work Performed by Contractor—A owns certain undeveloped mineral lands, and contracts with B for exploration to locate deposits that might warrant opening a mine.

Exploration expenses by B on behalf of A may be treated by A as if incurred directly.[1] The year of deduction depends on when the expenditure is paid or incurred. When the amount of unbilled contracts is material, and a reasonable estimate can be made, the liability therefore should be estimated and the election by an accrual-basis taxpayer should be made in the year when the expenditures are incurred. However, payments to contractors in advance may be considered prepayments, with no deduction allowed until the work is actually performed.

This treatment would not be limited to strictly agency arrangements. A should be entitled to the election under split-check as well as more-common contractual arrangements, split-check meaning certain rights to mine for the contractor and splitting of the check for the proceeds between owner and contractor. In any instance in which the owner can show that the expenses were paid or incurred in his behalf, he is entitled to treat the proceeds assigned to the contractor as development expenditures.[2]

1. Reg., Sec. 1.615-1.
2. Cresson Cons. Coal Mining & Milling Co., v. Comm'r., 11 TC 192; Utah Alloy Ores, Inc. v. Comm'r., 33 TC No. 103.

26. Deferred Exploration Expense Where Property is Sold—Corporation A owns certain mineral deposits and has previously deferred $100,000 of exploration expenditures in accordance with one of the elections permitted by the IRC.[1] Of this, $50,000 has been amortized in prior years. A sells the mine to B during the taxable year.

In computing sale gain or loss, A will add the deferred expenditures at sale date to the adjusted tax-cost basis of the deposit.[2] If all the depletable base has been recovered through percentage depletion prior to the sale, its adjusted tax-cost basis for computing gain or loss would be the sum of the undepreciated portion of its depreciable mine, buildings and equipment, and the unamortized portion of any previously deferred exploration and development expenditures.

Corporation B will not be entitled to any deduction for amortization of deferred exploration expenditures,[3] and will be required to capitalize the entire purchase price as depreciable or depletable base.

1. IRC (1954), Sec. 615(b).
2. IRC (1954), Sec. 615(d).
3. Reg., Sec. 1.615-1(b) (4), and Reg. 118, Sec. 39.23(ff)-1(a) (1).

27. Amortization of Deferred Exploration —Partnership—Corporation A was formed to explore and develop an iron-ore deposit, incurring and electing to defer in 1957 and 1958 expenditures of $100,000 each year.[1] A entered into a joint development and mining venture with B in 1959, A contributing its mineral deposits. Net income was to be split 50:50. There were no special provisions regarding exploration, development expenditures, etc.

It is clear that the deferred exploration expenditures are to be taken into account in determining the partnership's tax-cost-basis in determining gain or loss.[2] However, it is not clear whether the expenditures can be amortized as the ore is mined. With respect to the partnership as an entity, the problem is the same as that pertaining to pre-1954 expenditures transferred in a nontaxable exchange.[3]

For A alone, there should be no question of right to claim its pro rata share of the amortization of exploration expenditures. The partner is the taxpayer in a partnership.[4] This distinguishes the situation from a corporate reorganization, and should clearly establish A's right of amortization as the ore is mined.

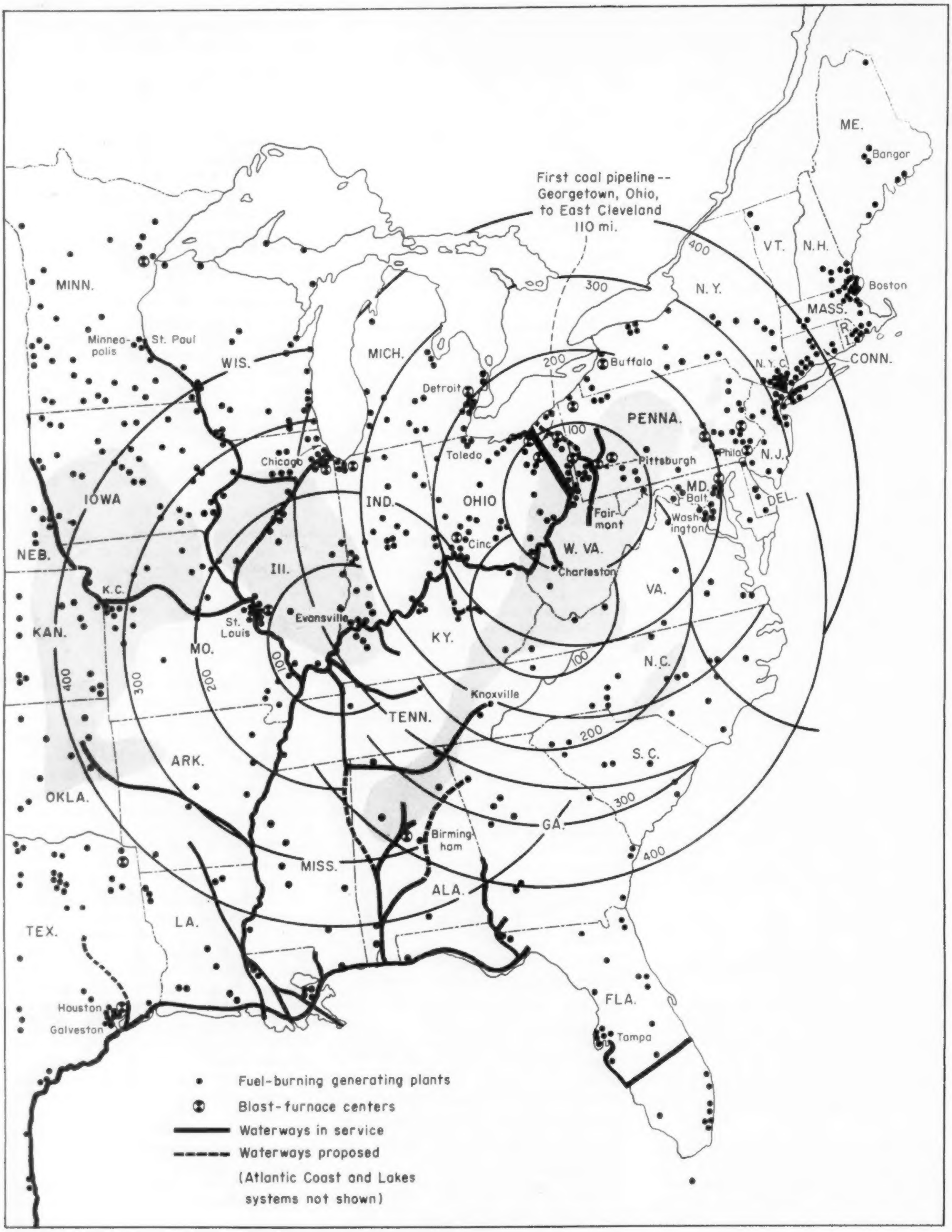
1. IRC (1954), Sec. 615.
2. IRC (1954), Sec. 615(d), 723
3. Reg., Sec. 1.615-1(b) (4).
4. IRC (1954), Sec. 701.

[MINE DEVELOPMENT EXPENSE — The second and concluding section of this analysis of exploration and development expenses for tax purposes, scheduled for an early issue, will cover development.]

Is It Low?

The prospect of a flood of low-priced Canadian gas has been giving coal men twinges recently. But is it going to be low cost? Not if the experience of the Montana Power Co. is any criterion. It is getting ready to really jack up its rates—because it is having to go to Canada for gas and is having to pay plenty.

The story? See the *Coal Age* News Roundup this month (p 26). Here you will find both details and interpretation—another example of another *Coal Age* service, in this instance in marketing and utilization, two of the 21 management functions covered regularly with the first and the best.



One Line . . . And More to Come?

Electric utilities are expected to be the main objectives in coal-pipeline construction. This map shows the fuel-burning power stations in the eastern half of the United States, as well as the first 110-mi coal line from Georgetown, Ohio, to E. Cleveland. Another being considered is from northern West Virginia to Philadelphia and New York. Cross country mileages from other producing centers to other consuming centers—utility and steel—are shown by the arcs and circles on this pipeline-distance map. Interior waterways are included to round out the picture.

Coal Pipelines . . . Progress and Prospects

FOR THOSE who would like to see where they might like to build a coal pipeline, the editors of *Coal Age* provide the map on the opposite page. It is of the eastern half of the United States, which is where the big part of the population is—70.3% of the people of the United States live east of the Mississippi, according to the 1960 Census. And where the people are is where business is done, so this area accounted for around 70% of the total "value of manufactured shipments" in 1960.

In view of all this it is not surprising to find that the East is where the power plants are—and these power plants are now coal's major targets as well as customers. The map spots all the fuel-burning stations—coal, oil and gas—as far west as east Texas, working from the 1961 directory of fuel-burning electric-power stations compiled by *Keystone Coal Buyers Manual*, a *Coal Age* affiliate. These stations burn all but a few million tons of the total coal used for generating electricity, which total was 176,000,000 tons in 1960, and is expected by the power companies to rise to 243,000,000 tons in 1965.

Except for a few million tons, all the steel is produced in the area east of the Mississippi, and almost all the new aluminum-reduction capacity also is found in this area.

The Concentration Picture

Inspection of the map quickly shows very-heavy power-station concentrations in certain sections, in addition to the blast-furnace concentrations in the Chicago-Gary and Pittsburgh-Youngstown-Warren-Cleveland areas, with lesser concentrations and single plants elsewhere.

Among the outstanding power-station concentrations are those at St. Louis, Chicago, Milwaukee, Detroit, Cleveland and Pittsburgh. But for numbers and fuel-burning capacity, "Power-Plant Alley," from Washington north to Boston, stands head and shoulders over all the rest. And here also, coal is confronted by imported residual—its principal competitor at the present time as far as power plants are concerned. Elsewhere, except in the South and Southwest, oil is no great problem or is declining, and natural gas has begun to recede. For example, gas has lost several major plants in Alabama and Georgia, and oil has been displaced by coal in one Florida Gulf Coast plant, with others undoubtedly to come. The chances are good that coal will spread along the Gulf Coast to New Orleans and perhaps even farther west.

Low-cost coal, low-cost water transportation and a new philosophy in railroad freight rates are the major reasons for the changing picture along the Gulf Coast, where coal's improved competitive power, and the further strengthening to come, has led one southern natural-gas distributor, stung by major losses, to charge "dumping" of coal. This could well qualify as the switch of the century.

Incidentally, the map shows how the waterway part of the proposed metallurgical haul to the West Coast would be set up. From southern West Virginia, eastern Kentucky and Virginia, the coal would go down the Ohio and Mississippi in barges, then west through the Gulf Intracoastal Waterway to Galveston, where it would be transferred into cars for the trip to the Pacific Coast. An alternative is rail to Norfolk and collier through the Panama Canal.

The Pipeline Picture

But what about coal pipeline possibilities? So far, the first and only coal line is the 110-mi Hanna installation from Georgetown, Ohio, to the E. Cleveland plant of the Cleveland Electric Illuminating Co., regularly deliverying around 1,250,000 tons a year — substantially above designed capacity.

Where will the next coal pipeline be? One of the possibilities is a line from northern West Virginia to the Philadelphia-New York area, though destinations are still, like the lines themselves, speculative. But on this and other possibilities, the 1960 annual report of the Consolidation Coal Co. had this to say:

"We have mentioned in past years the successful operation of our first coal pipeline in Ohio. By means of this original unique method, transportation costs were very materially reduced. Together with Texas Eastern Transmission Corp. we have been working closely with a group of eastern utilities looking toward the construction of a line from our northern properties to the Eastern Seaboard area. Economics of such a line appear to be favorable. There are other routes where pipeline transportation appears to offer opportunity for substantial savings and these contacts are being developed as rapidly as practicable."

On June 14, Texas Eastern pumped 200 tons of coal between two stations in Pennsylvania as "one of a number of experiments being conducted in connection with seeking a cheaper method of transporting coal."

Economics unofficially are being based on a 20-in line or larger with a minimum yearly delivery of 6,000,000 tons, which should provide ample savings and permit full amortization. The original line, with an overall diameter of 10¾ in, was completed in 1957 and, as previously noted, is delivering over 1¼ million tons a year of a 50% coal and 50% water mixture. New lines probably will handle the "stabilized slurry" developed by Consol, which permits raising coal percentage to 60 or more. Research has shown that this slurry can be burned without dewatering in cyclone furnaces, and also in pulverized coal furnaces with minor modifications.

The Savings

What it costs to transport coal by pipeline still is one of its developer's most closely guarded secrets. But as Consol has noted, transportation costs are "very materially reduced." As line diameter increases and throughput rises the reduction is enhanced.

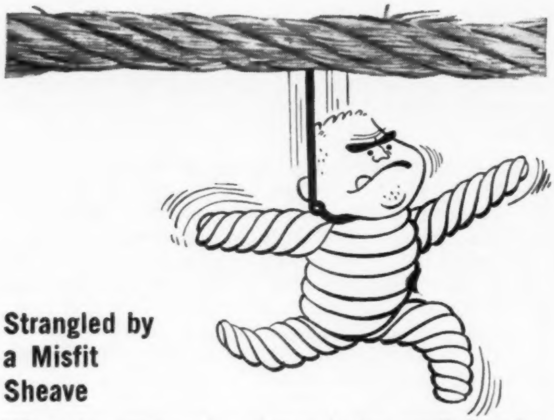
The fact that a coal line exists and that lines in general can move coal at very low costs means that the trend is downward in mine-to-market transportation charges in the heavily-industrialized East — and perhaps elsewhere. In fact, one journal specializing in pipeline construction and operation has gone so far as to say that there will be numerous coal lines in the future.

Union Wire Rope

In Union, There Is Quality That Responds

Overloaded—Soon Exploded

The rated capacity of a wire rope is based on the breaking strength (catalog) divided by a safety factor applicable to the type of service or use. The grade of steel, type of construction and size of the rope determine tensile strength. It must be properly related to the loads it will carry, or costly and dangerous early failures are likely to occur.



Strangled by a Misfit Sheave

When the groove of a sheave is too small for the rope diameter, pinching action quickly destroys the rope—especially when it's overloaded. The victim shown here was knocked out in just 1½ hours of service.

UNION Wire Rope Tuffys—Famed For Tough Job Performance

Tuffy Scraper Rope

Flexible enough to take sharp bends; stiff enough to resist looping and kinking when slack; highly resistant to the shock of load impact—that's Tuffy balanced construction. Mount a reel on your scraper—save wasting sound rope.

Tuffy Slings and Hoist Lines

Slings are a patented, 9-part machine-braided wire fabric that is next to impossible to knot or kink. Hoist lines have built-in strength, toughness, flexibility. Balanced—a top-performing team for handling every type of material. In addition to Tuffy, Union Wire Rope furnishes a complete line of slings.

Tuffy Dozer Rope

Mounts right on your dozer in a 150′ reel. When rope shows wear, just feed through enough to replace the damaged part. Saves rope, gives you a bonus of extra service. Also available in 300′ and 500′ reels.

Union Knows the Ropes—Comes Up With Solutions To Wire Rope Problems And we have 'em—more than 1600 standard constructions. Add to that the famous Tuffy family of special ropes and slings, custom-made for special needs and special uses. If none of these fit your needs, our research laboratory engineers and field staff are at your service. They'll build you just the rope or sling you need—with Union toughness and Union quality all the way. Ask your Union distributor—listed in the phone book Yellow Pages.

Preventive Maintenance: Electrical

Preventive-Maintenance Check List

Date . . . . Equipment No. . . . . Voltage . . . .

Serial No. . . . . Horsepower . . . . Location . . . .

Pull disconnect switch before working on control.

Check	Item	Operation
☐	**Dust.**	Clean.
☐	**Rust and Corrosion.**	Clean. Report if excessive.
☐	**Connections.**	Tighten electrical connections. Look for discoloration of any copper current-carrying parts.
☐	**Nuts and bolts.**	Check mechanical connections.
☐	**Fuse clips.**	Check spring clip pressure.
☐	**Fuse ferrules.**	If copper, polish. Check for loose ferrules and make sure fuse size is correct.
☐	**Contact tips.**	Look for copper-oxide scale, dress only if necessary. Check roll and wipe.
☐	**Contact pressure.**	Check contact pressure. Is pressure same on all tips?
☐	**Flexible leads.**	Look for frayed and broken strands, and flexing over entire length.
☐	**Bearings.**	Do they move freely? Do not oil.
☐	**Coils.**	Check for any signs of overheating or mechanical injury.
☐	**Magnets.**	Clean faces. Check shading coil, misalignment, mechanical binding and striking coil.
☐	**Overload relays.**	Trip by hand, mechanically free, clean, check heater coil and tighten all connections.
☐	**Arc shields.**	Check for breaks and burning.
☐	**Blowout coils.**	Check for overheating and tighten.
☐	**Dashpots.**	Free. Clean if oil type. Check oil level.
☐	**Push-button or selector switch.**	Clean. Check contacts.
☐	**Relays.**	Clean and check for mechanical binding and sticking. Check contacts.
☐	**Resistors.**	Check for signs of overheating. If sliders, tighten.
☐	**Oil-immersed devices.**	Drain small quantity from bottom to remove sludge. If much sludge is present, drain oil and clean. Check level and add, if necessary. Replace oil if black and dirty. Check contactor and wipe off carbon.
☐	**Drum controllers.**	Tighten and check for contact wear and overheating. Put small amount of vaseline on sliding surfaces.
☐	**Pilot devices.**	Clean and check contacts.

Start the Motor Observing All Safety Precautions for Driven Machines.

Check	Item	Operation
☐	**Check starting sequence.**	Does the control function properly?
☐	**Contactors.**	Flash on closing, if so, check for adjustment to eliminate contact bounce.
☐	**Noise.**	Check shading coils, magnet surface, sealing, mechanical binding, loose rivets.
☐	**Pilot devices, pressure switches, temp. switches**	Check bottom and top limits of operation. Is there any fluttering of contacts denoted by pumping of main contacts?

List parts which will have to be replaced in the near future.

PROPER APPLICATION OF CONTROLS, adequate design of the electrical system and a good maintenance program will assure trouble-free service from most electrical control devices. Some of the difficulties common to electrical controls are pointed out in this article by Allis-Chalmers Mfg. Co. It includes a troubleshooting chart and a preventive-maintenance check list to serve as a guide in setting up a thorough maintenance program.

Maintenance Practice

Failure to recognize symptoms and correct trouble quickly can lead to a chain reaction which results in higher maintenance costs and a possible need for complete replacement of the device.

Only skilled personnel should be permitted to service control units. All safety precautions should be observed, not only on the electrical equipment but on the driven machines as well. A periodic-inspection schedule and precautionary maintenance program will result in savings in replacement parts and reduce machine downtime.

Maintenance Tips – All controllers should be kept free of dust, dirt and grease. Dust can cause mechanical failure and may form a conducting path between points of different potential, resulting in a short circuit. Dry dust can be blown off. Sticky dust and grease are best removed with a commercial solvent. Care must be taken to avoid soaking operating coils with the solvent. Rust and corrosion must be given special attention, particularly on thermal overload relays.

Most control devices contain moving parts which should be free of excess friction. These parts should be tested by hand to locate loose pins, bolts, excessive wear, etc. The bearings on electrical control equipment are designed to operate without lubrication. If lubricated, dirt will accumulate and cause sluggish action and possible failure.

Overheated parts are always a sign of trouble. And since various parts operate at different temperatures, it may be difficult to locate the source of trouble. For example, operating coils, blow-out coils and other parts

Controls

may operate at a temperature that will boil water, hence these parts cannot be touched. However, when there is evidence of baking or smoking, the trouble should be located and corrected immediately.

Loose connections are always a source of trouble and they may develop at any time. Therefore, control connections should be checked periodically along with the main-line connections.

The best way to check for grounds is to megger the cables and conduits periodically. This is especially necessary if moisture can collect in the conduit.

Contactor Care—Contactors need the most care. Deposits on contacts should be removed with either sandpaper or a fine file. Never use emery paper because it imbeds in the contact face and increases wear. If a file or sandpaper is used, care should be taken to maintain the original shape of the contact. Efforts to keep them smooth will only waste the material of the contact surface. Silver contacts should never be filed unless they become severely roughened.

Copper oxide should be removed because it is an insulator. Silver oxide is a good conductor and does not need to be removed. When contacts are deeply pitted, burned or worn, they should be replaced in sets. Keep contact screws tight.

Springs maintain the proper contact pressure. If contacts are permitted to wear too thin, spring pressure decreases and overheating results. This generally causes the spring to lose its temper, further decreasing the contact pressure. Spring tension should be checked with a scale in accordance with the manufacturer's recommendation. If a scale is not available a comparison test can be made between the installed spring and a new one of the same design. Springs may be checked by compressing with the fingers to determine whether one is weaker than the other. A good rule to follow is to replace contact springs when replacing contacts.

Operating Coils—New methods of impregnation have greatly reduced

Control Trouble-Shooting Chart

Symptom	Possible Cause	Cure
	MANUALLY OPERATED CONTROLLERS	
Excessive contact burning.	Low contact pressure. Contacts not properly aligned.	Adjustment by inspection. On drum controllers adjust star wheel lever spring to center the finger so it strikes the contact squarely.
Burning out resistors.	Starting sequence stopped at midpoint.	Instruct operator.
Failure to pick up.	Low voltage on coil.	Check system.
Failure to hold in.	Coil burned out or wrong coil.	Replace.
	Excessive magnet gap.	Check gap.
Failure to drop out.	Mechanical binding.	Clean and adjust.
	Contact welded.	See contacts.
	Voltage not removed.	Check circuit.
	THERMAL OVERLOAD RELAYS	
Failure to trip.	Wrong size heater.	Check instruction sheets.
	Mechanical binding.	Clean and adjust.
	Relay damaged by short circuits.	Replace relay.
	Motor and relay in different ambient temperatures.	Install motor and control in uniform temperature.
Trips at too low current.	Wrong heater.	Check instruction sheets.
	Heater assembled incorrectly.	Check instructions.
	Heater in high ambient.	Install relay and controller near motor or in cooler place.
	Wrong calibration.	Refer to factory.
Trips on starting.	Starting cycle of motor too long.	Refer to factory.
Failure to reset.	Broken mechanism.	Replace relay or broken part.
Burning of relay contacts.	Short circuit.	Check wiring of push-button in the circuit.
	High coil current.	Check holding coil current.
	Vibration.	Remount control.
	Dirt and corrosion.	Clean and adjust.
	Misapplication.	Use interposing relay if handling too high coil currents for relay contacts.
	CONTACTS	
Short contact life.	Interrupting too high a current.	Use special tips or next larger size contactor.
	Using oil-immersed device when air should be used. (Contacts burn many times faster in oil than in air.)	Use air-break device if oil is not necessary or if oil is imperative, try heavier duty oil-immersed device.
	"Bounce" on opening or closing.	Readjust contactor for "bounce."
	Abrasive dust.	Dust-tight enclosure.
	Low contact pressure.	New contacts and/or springs.
	Frequent jogging.	Larger size contactor.
Contact chatter or pumping.	Poor contact in control circuit.	Check connections in control circuit.
	Fluttering control relay such as pressure or temperature switch.	Repair pilot device.
	Broken shading coil.	Replace.
	Bad interlock.	Increase wipe and pressure on sealing interlock.

Control Trouble-Shooting Chart *(Continued)*

Symptom	Possible Cause	Cure
Overheating.	Copper oxide.	Clean lightly with file.
	Heavy load for more than 8 hr continuous operation.	Use silver alloy tips.
	Overloaded.	Reduce load or use larger control.
	Weak contact pressure.	Clean and adjust. Replace spring and contact if wear allowance is used up.
	Poor connection.	Tighten.
Weak pressure	Worn tips.	New tips.
	Poor adjustment.	Readjust gap and wear allowance.
	Low voltage, magnet not sealing.	Correct voltage. Use lower voltage coil.
Welding of contacts.	Poor spring pressure.	New springs.
	Abnormal currents.	Less current, larger device or nonwelding contact tips.
	Repeated jogging or inching.	Controllers must be derated for jogging duty due to severe strain. Use next larger device or tell operator to jog more slowly. Special alloy tips may also help.
	Low voltage, contact may drop part way open on slow dips of voltage.	Raise voltage.
	Bouncing of contactor.	Eliminate overvoltage and / or mechanical difficulties.
	COILS	
Open circuit.	Contacts not sealing.	Eliminate mechanical binding.
	Failure to insert protective resistor on DC.	Interlock not making contact. Repair interlock.
	Mechanical injury.	Replace coil. Use more care.
	Very rapid jogging.	Check application.
	Short time rated coil energized too long.	Check timing sequence.
	Overvoltage and/or high ambient.	Check circuit and application.
Coil failure.	Moisture or corrosive atmosphere.	Special coils.
	SLIDING CONTACTS Used on Rheostats, Knife and Drum Switches	
Overheating.	Overcurrent, weak contact pressure.	Dress copper contacts or use special alloy contacts. Lubricate.
Excessive burning.	Rapid lever operation.	Operate more slowly to eliminate starting across the line.
Irregular surfaces.	Lack of maintenance.	Smooth contact surface and lubricate. Do not use emery cloth.
Abrasion.	Lack of lubrication.	Apply light coat of vaseline.
	MAGNETS	
Noisy.	Low voltage.	Raise voltage or use lower voltage coil.
	Broken shading coil.	New shading coil or if face of magnet is worn install new magnet frame.
	Dirt.	Clean sealing surface of the magnet and bearing points. Lubricate with good grade of white machine oil.
	Misalignment.	Realign.
Fail to open.	Grease on magnet surface.	Clean.
	Misalignment.	Realign.
	Contacts welded.	(See contact welding).

coil burnouts. However, in the event of an AC coil failure, the contactor should be checked for mechanical binding or blocking. For example, an AC contactor coil may have a 47-amp inrush value with the magnet opened and 1.7 amp with the magnet closed. If the magnet is accidentally blocked open or the voltage is so low that the magnet cannot seal against the contact springs, the current will be high, causing a burnout.

Connectors made of fine stranded wire are subjected to repeated flexing. Eventually some of the strands may break and the current increased on the remaining strands. In such instances the lead should be replaced. New leads should be formed by hand so that flexing will be distributed over the entire length rather than at one point.

Arc shields should be checked to make sure that they are in place and free of dirt. Carbon or copper deposits which form on the faces of the shields should be removed.

Some controllers are equipped with dashpots which may be air or liquid filled. Special dashpot oil should be used in the oil type. Dashpots should be checked to make sure they are not sticking or binding.

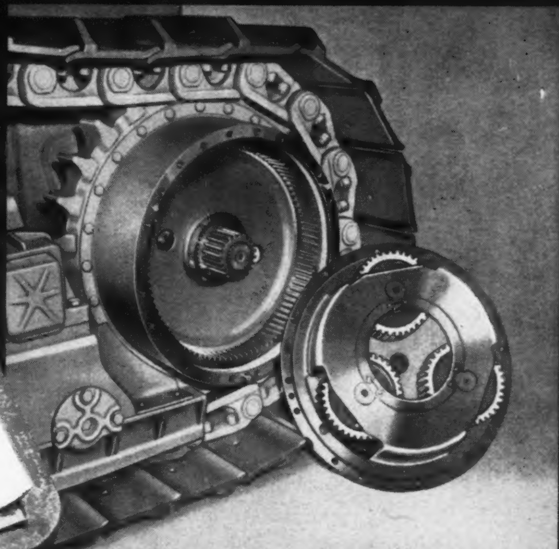
The oil level should be maintained in high-voltage contactor and circuit-breaker controls of the oil-immersion type. The oil also should be tested periodically for water, sludging and excess carbon.

Coming In Maintenance Ideas

"What You Should Know About Power Factor." Explained and illustrated in layman's terms, this article will describe the effects of power factor in an electrical system and emphasize the need to maintain a good power factor for economy reasons.

"The ABC's of Testing Hydraulic Circuits." Such topics as how to test hydraulic circuits, what the benefits of good test procedure are, necessary test equipment and test procedure will be discussed.

For more articles of interest to maintenance and management men containing detailed discussion on electric power, maintenance and supplies, respectively, turn to pp 248, 257, 269, in this issue.



...a saving of 15 hours labor and productive time with the C-6 and no special tools required!

C-6		Crawler "C"	
Planetary Gears	3 hours	Gears and Bearings . . .	16 hours
Inside pinion and drive gear reduction . . .	11 hours	Top pinion from steering clutch with bearing and shaft	13 hours
Total	14 hours	Total	29 hours

Times shown are for removal and replacement of final drive with all components in place.

With a 15 hour saving for final drive replacement the "Euc" C-6 gives you 15 hours more productive time on the job! Easy accessibility that's designed into the C-6 and Euclid's time-tested planetary drive save hours of repair labor . . . that means less downtime and more production. Compare these savings in terms of lower costs . . . add the extra hours available for work on the job . . . then you'll see what just this one advantage can do in cutting operating cost.

The Euclid dealer in your area would like to prove that the C-6 is the lowest cost tractor in the 200 h.p. class . . . and the most versatile by far. He's sure of it, and wants you to know the facts, too!

GM GENERAL MOTORS

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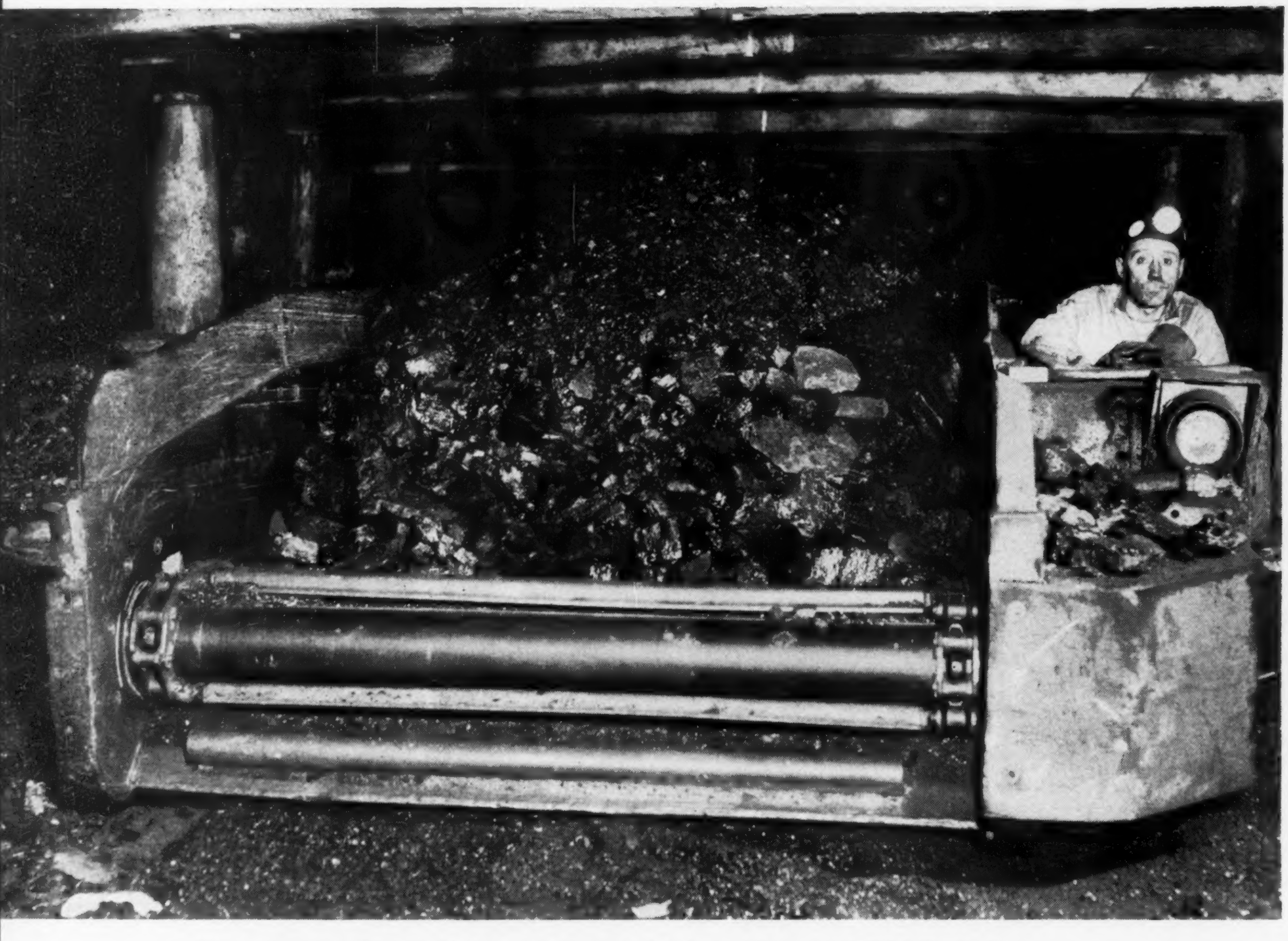
DIVISION OF GENERAL MOTORS, HUDSON, OHIO

Plants at Cleveland and Hudson, Ohio and Lanarkshire, Scotland

AT CENTRAL APPALACHIAN COAL:

OPERATORS LIKE THE WAY MANAGEMENT LIKES THE

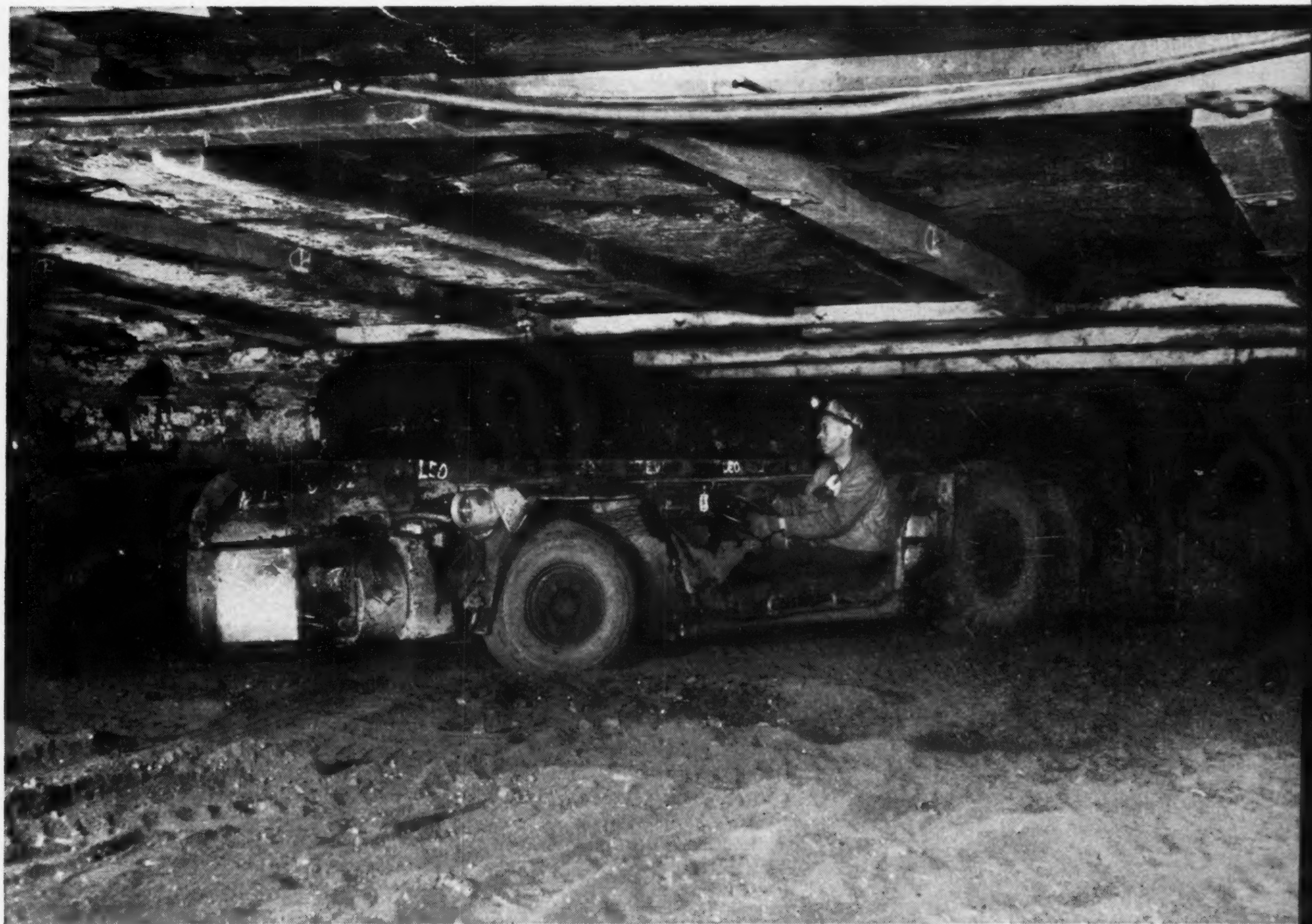


Mine management likes the big load, and the quick trip time of these new 18SC-2 Shuttle Cars.

Joy 18SC-2 six-wheeled Shuttle Cars have proven popular with both operators and management at the Central Appalachian Coal Company. Operators like the comfortable, safe ride between the wheels, and the easy way they handle. This results in cutting trip time substantially. Mine management likes the big load the 18SC can carry. Operating in 60″ seams, a 32″ car with 6″ sideboards is hauling over six tons per load, up grades as steep as 12%.

The Joy 18SC-2 cars at Central Appalachian are part of a complete line of six-wheeled shuttle cars available from Joy. In any low or medium seam from 30″ to 54″, these cars cut your haulage costs with shorter trip times and bigger loads than any conventional car can provide. Let your Joy representative give you complete details on these cars, or write for Bulletin 2611-1.

THE 6 WHEEL 18SC RIDES... BIG LOAD IT CARRIES



Operators like the ease of handling, and the safe comfortable ride in the Joy 18SC Shuttle Cars. Hinged center enables car to take bumps and dips in stride.

WORLD'S LARGEST MANUFACTURER OF UNDERGROUND MINING MACHINERY

JOY

Coal Drills	Coal Loaders	Coal Cutters	Shuttle Cars	Continuous Miners

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

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44th NCA Convention

THE SPIRIT was one of resolute confidence at the highly successful 44th annual convention of National Coal Association at Washington, D. C., June 7-8, where delegates heard reports of a forward-looking program upon which the reorganized association will embark. It was reported that the streamlining of NCA has resulted in savings of approximately a half-million dollars in operating expenses, while permitting a reduction from 8½ to 8 mills in tonnage assessments of member companies.

The staff of NCA described the steps that must be taken in research, public relations and marketing to achieve a 500-million-ton level of business, which is the immediate goal of the industry.

Representatives of other industries using coal or serving the coal industry — electric power, steel, railroads, equipment manufacturers — pointed out that coal has rising opportunity, provided all parties cooperate in exploiting the opportunities to the fullest extent.

Among other highlights in the annual reports are:

1. The BCR laboratory at Monroeville, Pa., is in advanced stages of construction and should be ready for occupancy and business in the Fall.

2. Coal's voice is heard with increasing clarity on Capitol Hill.

Government officials brought word of activities vital to coal. Rep. Oren Harris (D.-Ark.), chairman of the House Interstate and Foreign Commerce Committee, told of the introduction of his billl intended to bring order out of chaos in the natural gas situation. Assistant Secretary John M. Kelly, Dept. of the Interior, pointed out that while it is difficult to develop a single overriding government policy on fuels, the Dept. of the Interior nevertheless strongly endorses legislation which would institute a national fuels and energy study. George A. Lamb, director of the newly-organized Office of Coal Research, Dept. of the Interior, reported that what the Office has to offer is not subsidy. It offers instead an investment in coal's future by providing financial assistance in developing imaginative plans already afoot in the industry. Many projects for OCR support have been submitted and are now being evaluated.

NCA Progress Report

Membership in NCA is steadily growing more attractive, declared Stephen F. Dunn, president, NCA, in pointing out that 62 new member companies have joined, including 42 producers and 20 sales companies. In the past year NCA has instituted a new group insurance plan for member companies.

In the past year, the Market Promotion Div., headed by Glynn Coryell made 2,227 calls on consulting engineers and architects. In addition, the division worked on 984 specific projects involving new construction and on 370 coal accounts threatening to convert to competitive fuels. Net result was the creation of 1¾ million tons of new coal business, the retention of 900,000 tons that was in jeopardy and the establishment with professional engineers of a better understanding of what the coal industry has to offer. NCA air-pollution experts have contributed to the retention of approximately 700,000 tons of annual business by helping municipalities and industries solve smoke problems.

The functions of governmental relations and law departments have been merged to increase the effectiveness of both. The educational section has distributed nearly 30,000 teaching aids on coal to school teachers all over the nation, among numerous other activities. The NCA has completed a pilot study of Cambria County, Pa., offering an approach and a program in tackling the depressed-area problem. The objective is to attract coal-consuming industries to coal-producing areas, thus revitalizing the local economy and adding to local coal production.

Prospects for the '60's

A panel of executives of the steel, rail, power and manufacturing industries, chaired by G. A. Shoemaker, president, Consolidation Coal Co., took a look at coal's prospects. Abstracts of their remarks are as follows:

Electric Power and Coal, Allen S.

NCA Elects Officers

GEORGE E. ENOS, president, The Enos Coal Mining Co., Cleveland, was elected chairman of the board of directors of National Coal Association, succeeding Herbert E. Jones Sr., chairman of the board, Amherst Coal Co. Mr. Enos is also president of Enoco Collieries, Inc., Bruceville, Ind., and vice president and treasurer of Algers, Winslow & Western Railway Co.

H. Vernon Fritchman, executive vice president, Rochester & Pittsburgh Coal Co., Indiana, Pa., was elected NCA vice chairman, succeeding Mr. Enos. **Stephen F. Dunn** continues as full-time president of NCA, and **Thomas Howarth** was elected secretary-treasurer. Mr. Howarth has been serving as secretary and assistant treasurer.

Directors-at-large elected to the board are:

D. W. Buchanan Jr., president, Old Ben Coal Corp.; **F. Stillman Elfred**, chairman of the board, Peabody Coal Co.; **John L. Kemmerer Jr.**, chairman of the board, Wise Coal & Coke Co.; **C. B. Lakin**, president, Berwind-White Coal Mining Co.; **P. F. Masse**, president, C. H. Sprague & Son Co., Inc.; **Huston St. Clair**, president, Jewell Ridge Coal Corp.; and **G. A. Shoemaker**, president, Consolidation Coal Co.

Elected as regional directors are:

West Virginia—**L. Newton Thomas**, president, Carbon Fuel Co., and **Laurence E. Tierney**, president, Eastern Coal Corp.

Pennsylvania — **George E. Owen**, chairman of the board, Imperial Coal Corp.

Ohio—**Henry G. Schmidt**, president, North American Coal Corp.

Virginia and Maryland—**E. B. Leisenring Jr.**, president, Stonega, Coke & Coal Co.

West Kentucky—**Mark Eastin Jr.**, president, West Kentucky Coal Co.

Alabama, Tennessee, Georgia — **Charles R. Griffith**, president, Southern Coal & Coke Co.

King, president, Northern States Power Co., Minneapolis, Minn.

A number of independent estimates of the future growth of the electric power industry all point to a continuation of the doubling-every-decade history of the industry. Factors leading to this conclusion are (1) growth in population, (2) rise in summer air-conditioning, even in northern areas, (3) increasing interest among power-company customers in electric home heating, (4) the rise in automation, which increases use of electricity in industry.

Not all of the utility expansion will be in fuel-burning plants. According to best estimates, steam plants in 1970 will produce 225.4 million kw, as against 111.8 million kw in 1959.

The use of gas for power production will be declining 10 yr from now, provided coal-mining interests continue the progress already made in lowering unit cost. It is estimated that 1970 requirements for coal in power generation will be 300 million tons. This allows for increasing efficiency in power generation. At this date the electric utilities should account for about 60% of the total consumption of coal in the U. S., as against 45% in 1960.

Coal Traffic on the Railroads, Stuart T. Saunders, president, Norfolk & Western Railway Co., Roanoke, Va.

In 1960 the railroads transported nearly 303 million tons of coal – about 73% of total production. More than $3 billion is invested in coal-transportation facilities by the railroads. Last year N&W handled 61 million tons and received 71% of its freight revenue from this source. Of the 79,000 freight cars owned by N&W, more than 66,000 are used for coal shipments, representing an investment of some $650 million.

In the past 5 yr, N&W has purchased an entirely new fleet of 529 locomotives, constructed many thousands of 70-ton hopper cars and now is putting into service 1,000 new 85-ton hopper cars. Facilities for the overseas shipment of coal are being modernized and increased in coal-handling capacity at Hampton Roads. These steps all point to more efficient transportation of coal.

Rates have been reduced in some instances to keep coal competitive at point of use. For example, rates were reduced 50c per ton on hauls to Hampton Roads of coal destined for certain power plants in the Northeast, conditioned on total annual shipments of at least 1.2 million tons to the two destinations involved. Reductions ranging from 15c to 35c per ton have been made by N&W on approximately 2.8 million tons annually to destinations in Virginia alone.

One of the best opportunities for strengthening the railroads is through mergers and consolidations, thus eliminating overlapping and inadequately used facilities. The success of the N&W-Virginian merger strikingly illustrates these benefits. Trains are longer and faster and better dispatched, and trackage is more efficiently utilized.

Earns 1961 BCR Research Award

JOSEPH PURSGLOVE JR., vice president and director of research, Consolidation Coal Co., Pittsburgh, was awarded the 1961 Annual Award for outstanding leadership on behalf of industry-sponsored research. The award was established by the board of directors of BCR, the research affiliate of NCA, to stimulate technical progress in the bituminous coal industry.

Mr. Pursglove has been vice president of research and development for Consol since 1947. He is responsible for the largest research program ever undertaken by a single coal company, including economical conversion of coal into chemicals, special carbons, gaseous and liquid fuels, and the pipelining of coal to markets.

Mr. Pursglove is a director of BCR, a member of the Pennsylvania Coal Research Board, the West Virginia Scientific Advisory Council, and is a registered professional engineer in Ohio and West Virginia. The award was presented by Harry LaViers, president, South-East Coal Co., Paintsville, Ky.

The Outlook for Coal and Steel, Harold C. Lumb, vice president, Republic Steel Corp., Cleveland, Ohio.

Economists agree that the general business decline that spelled outright recession for the steel industry has ended; a general upturn has begun and it is expected that the rise will continue. Looking ahead to the end of the decade, a rise is envisioned in steel capacity that will permit production to rise to 150-160 million tons annually. Coal will provide a major share of the heat of reduction, even though technological advances, such as direct reduction, will have strong influence. The coke rate per ton of steel is steadily declining, but instead of being a negative factor, this has gone far toward keeping coke competitive.

Oil and gas are being researched as partial replacement for coke. The two appear to work well as a team, oil offsetting the tendency of the gas to cool the blast furnace. In general, the key to their use is cost, with availability also a factor.

Most serious from the coal industry's point of view is the possibility that some new process will appear on the scene. However, the full potential of the blast furnace has not yet been realized. Furthermore, the steel industry is on a hot-metal basis and the blast furnace will continue to be about the best source of hot metal available.

In regard to present business climate, this country needs the maximum improvement in productivity that technological change can bring about. The only solution to the problem of unemployment, technological or otherwise, is a strongly growing economy. One of the pressing needs is a better policy on depreciation in order that basic industries may continue to modernize.

Prospects for the Sixties, W. L. Wearly, president, Joy Mfg. Co., Pittsburgh, Pa.

Coal faces greater competitive problems now than at any time in modern history. However, in the recent past one of the world's great technological revolutions has taken place within the industry in the mechanization and modernization of the mines. Results are high productivity leading to a stable product price, in spite of large increases in the cost of labor, supplies and fixed charges.

Substantial savings in the cost of producing coal can and will be made in the future, coming from increases in the productivity of men and equipment far above the best we know of today. We must achieve higher unit production, making possible more tonnage for a given fixed investment.

New concepts of mining will be unlike much of the mechanization of the past, which has been little more than the application of labor-saving machinery to traditional mining systems and procedures. The fuels which compete with coal are basically produced on a continuous process rather than on a batch or cyclical process. Can the coal industry really hope to compete with fuels pro-

duced by a continuous process on a round-the-clock basis, seven days a week?

An oil refinery operates, say, 8,760 hr per yr, while a coal "plant" may be utilized only 3,000 hr per yr (5-day week, two-shift operation). It is obvious that investment in the coal plant for underground mining has poorer utilization than that in an oil refinery or, for that matter, in a coal stripping operation. Placing coal production on a continuous basis would improve the turnover, or utilization, of investment. This is as valuable as an improvement in return on sales. Continuous production of coal also lends itself to automatic control, similar to that now being applied to the 7-day per week operation of the highwall Pushbutton Miner.

500 Million Tons—Where and How?

A third general session at NCA's 44th convention dealt with steps that should be taken to achieve the annual-production goal of 500 million tons. Abstracts of presentations by members of the NCA staff are as follows:

Research, James R. Garvey, director—research, National Coal Association, Pittsburgh, Pa.

Technical research can be the first link in the chain that must be forged to support the industry's effort to reach a 500-million-ton year in the near future. In our eagerness to use research as a creator of new markets, we must not overlook its equally important role of helping to capture markets that already exist. Coal's basic value right now is as a source of heat energy. Unless we prosper from the current uses of coal where it has an economic advantage, we shall not as an industry live long enough to reap the benefit of coal's future potential in chemicals.

The heat energy market has two major subdivisions, power or utility use and non-power use. The potential of the former is readily apparent, but that of the latter is not. It represents primarily heating loads that in 1955 consumed the equivalent of 500 million tons of coal. It is conveniently located with respect to coal-producing areas. If the coal industry can get its normal share of this, the 500 million ton goal can be reached without miraculous new uses of coal. The requirements are improved types of burning equipment and a well-planned servicing program for this burning equipment.

Public Relations, Rex Chaney, director — PR, National Coal Association, Washington, D. C.

We know that there are many more potential users of coal, but we do not know just how many or where they are. This information can be obtained through an intensive, scientifically-conducted market research program. Following this market research the circle may be completed through well-planned publicity and advertising. The public must be informed of the "new look" in the coal industry, actually the rebirth of a great industry.

In 1960 the American Gas Association spent almost $2 million for magazine advertising alone, and $1½ million for television advertising. The National Lumber Manufacturers Association has appropriated more than $1 million a year for public relations and product promotion. The Asphalt Institute and the Portland Cement Association spend millions of dollars a year to see who can swing the biggest chunk of business in the current road-building program.

On the other hand, coal has curtailed its modest program of selling the advantages of coal to architects, consultants and others directly engaged in the selection of fuel systems. In 1959, with the program in use, NCA received 1,890 requests for assistance from those who design for or burn coal. In the first quarter of 1960, with no such program of advertising, only 121 requests were received. This is a decline of about 75%.

We can help to stimulate interest in our product. We can make all classes of consumers conscious of the fact that coal must be considered in their plans.

Marketing, W. W. Bayfield, director—marketing, NCA, Washington.

Assuming the industry has developed good burning equipment; that qualified manufacturers are ready to build it; that we know the market and our potential customers have been informed of coal's progress, what more is required?

The market must be sold. This is the difficult assignment of convincing a non-user of coal that it will be to his advantage to burn coal. Customers have been conditioned to the proposition that natural gas and oil are modern and clean fuels and, by inference, that coal is old-fashioned and dirty. The mere fact that something is new does not make it better than an older product. If this were true, steel would be a dying industry for it has had to face the competition of aluminum and other glamour metals and alloys.

The steel industry is meeting the challenge. Through technical research it developed a product with new characteristics and new properties. It proved that steel can be as versatile and glamorous as the others.

Coal can do likewise. But if this sales job is to be done, it must be done by trained men. These men must be able to prepare and effectively present a complete comparative cost analysis, to answer all questions, to persuasively turn aside any doubts that may exist.

Another need is a sound financing program that will permit potential customers to more-easily take on the higher cost of coal-burning installations. Steps have already been taken to explore the possibilities of setting up such financing arrangements. If favorable conditions can be arranged, such as a 10-yr payback, a buyer would be able to offset his installment payments with his depreciation write-offs, thus obtaining immediately the benefit of his operating savings from the use of coal.

Coal Exporters See Market Growth

"WE ARE HAPPY to note that both the energy requirements throughout the world and the expansion of steel-producing facilities throughout the world are increasing annually," reported John S. Routh, president, Coal Exporters Association of the U. S., Inc., at the association's annual meeting in conjunction with the NCA convention. These developments, Mr. Routh said, mean a better, expanding market for the future. Energy requirements of Europe are expanding at an overall rate of 8% per annum, a trend which is expected to continue for 5 yr, and possibly 10 yr.

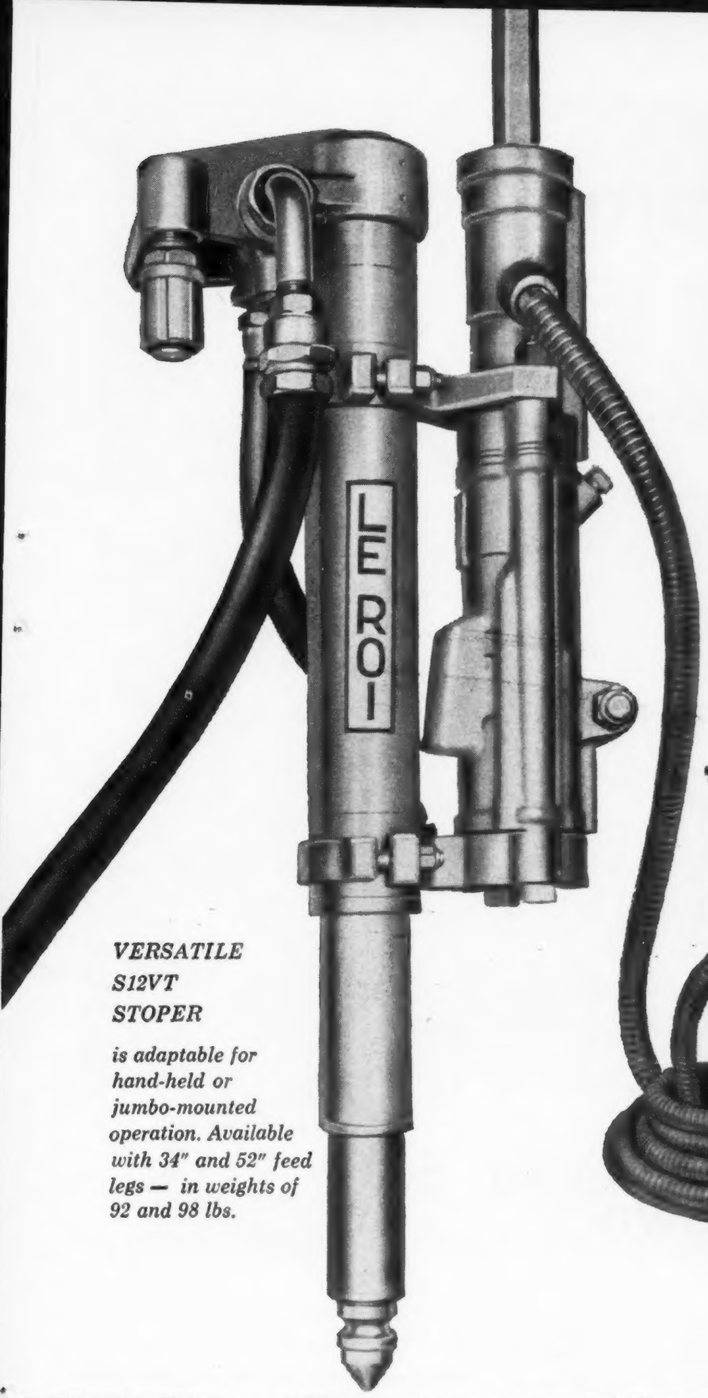
The expansion of steel in Italy is planned to increase production capacity by 40% in the next 3 yr. Brazil, Argentina, Chile, Venezuela and Colombia are building or contemplating new steel-making capacity.

The activity of coal exporters, in shipping coal to 44 countries, has resulted in the return of approximately $250 million annually to this country in balance of payments. This is a major contribution in helping to reduce the Nation's balance of payments deficit.

Principal speaker at the Coal Exporters luncheon at the Mayflower Hotel, June 8, was Count Casimiro Kulczycki, director of purchases, Societa Edisonvolta, Milan, Italy, who warned that the placing of the United States and the USSR on the same trade level in Europe would be grotesque. Russia is trading her raw materials for machine tools instead of finished goods so that she can undersell the free world, thus creating more unemployment.

On proposals to set up in Europe a single office to deal with all purchases of coal from ECSC non-member countries, Count Kulczycki declared that this would constitute a colossal monopoly which Italian industrialists believe will not be workable nor economical. These industrialists have the ability to choose for themselves the coal most suitable for their own uses. They are in favor of this freedom of choice to obtain competitive pricing which no European purchasing office could provide.

LOWER DUST COUNT THAN WET DRILLING



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is adaptable for hand-held or jumbo-mounted operation. Available with 34" and 52" feed legs — in weights of 92 and 98 lbs.

NEW LX-1 DUST COLLECTOR TANK

never needs emptying — dumps automatically.

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This hard-hitting stoper gives you more benefits and eliminates all of the problems and expenses of wet drilling! It delivers 20% harder, faster blows than comparable machines — has a much lower dust-count than wet drilling. Its exclusive dust-collecting system passes cuttings through the chuck housing — *not through the stoper!* Tools work better, last longer. Steel *never* sticks even in soft, wet formations — or in hard strata.

Special aluminum-alloy leg reduces weight, stops corrosion, and cuts maintenance. Controls are on the leg — not on the stoper — for better balance and easier operation.

Get the complete story from your Le Roi distributor. Or write to Le Roi Division, Westinghouse Air Brake Co., Sidney, Ohio.

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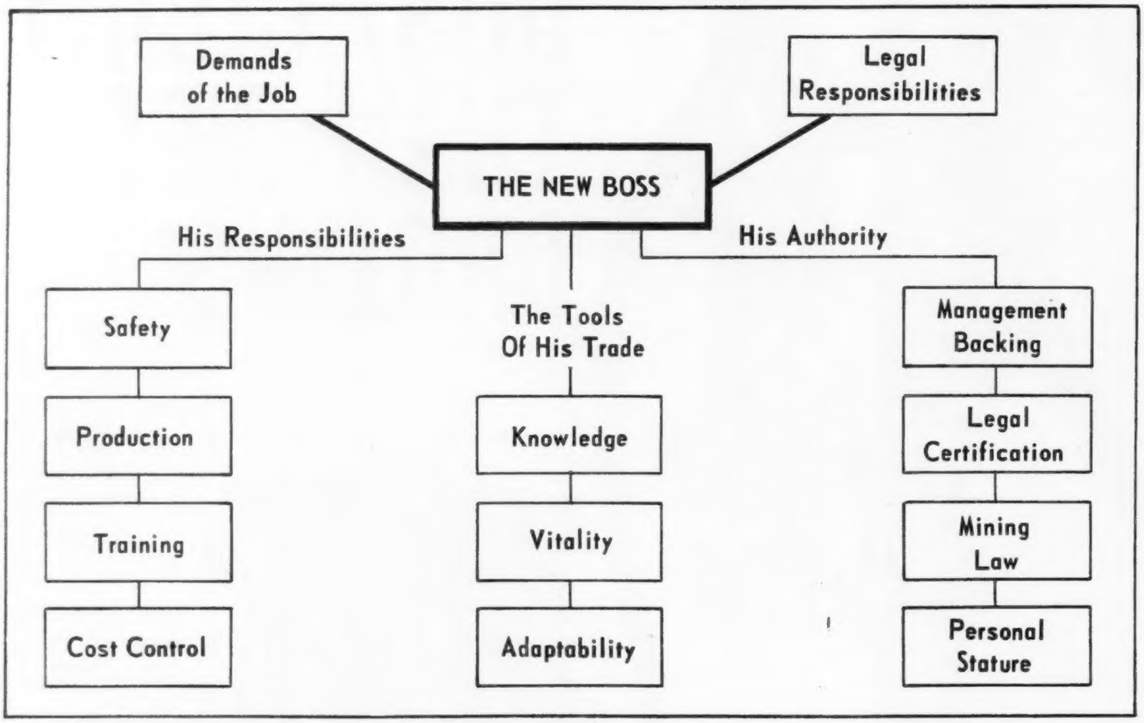
AT-901

Foremen's Forum



THE MANAGEMENT JOB—and how the new boss fits into it.

Uneasy Lies the Head That Wears the Crown

SHAKESPEARE said the words, in the title above, which are particularly fitting in the case of the newly-appointed assistant foreman. It's a sobering experience to leave the relatively sheltered life of hourly wage-earning to become a conspicuous boss, the target of everybody's barbs and shafts—or so it seems. However, you may find consolation in realizing that every man who makes the switch to a supervisory position experiences the same qualms. There is a period of adjustment that must be suffered through.

Each man in a position of responsibility must have some guiding principle deep in his "innards" to which he can refer in times of confusion and uncertainty. If you are waiting for us to suggest such a guiding principle, we offer the following as a possibility: Say to yourself, with conviction, as you approach your job, "I am a coach, not a psychiatrist."

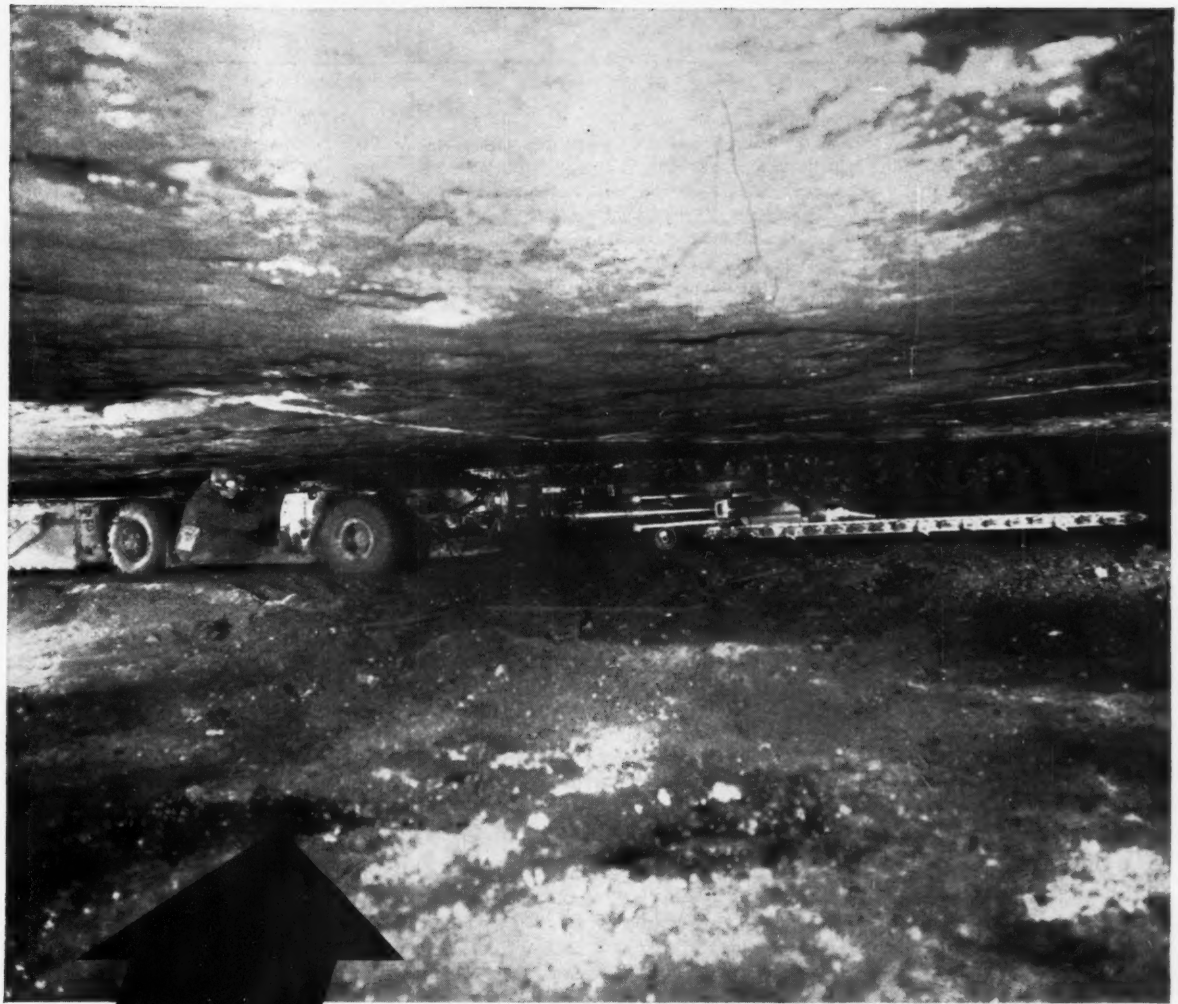
The coach motivates people to stand on their feet and think about the team. The psychiatrist, to be effective, must convince people to "lie down" and think about themselves. There is no intent to impugn the real values of the latter therapy. However, the new foreman should plan carefully, step out and lead; he should not become enmeshed in personalities. If you are a new foreman you know you have the required knowledge of mining in general and the required planning ability. Otherwise you would not have been chosen for your job.

Positive Approaches For the New Boss

Following are some approaches you can take to get and mantain firm control of your job:

• Place the accent on safety in the beginning of your supervisory career. Your interest in safety was recognized as one of your foremost qualifications for the job. Make up your mind to observe the letter and spirit of all rules and laws governing mine safety. Your training in safety may be the most intensive preparation you have had for your new position, so capitalize on that training by making certain that everything you do can be squared unequivocally with the safety rules.

• Learn your channels of communication within the company organization, both up and down. Observe them without fail. If you have information the super-



Improved hydraulic operation is just one of the ways in which a Texaco "Stop Loss" Program can help you cut losses and increase production

HERE is where Texaco can help you stop profit leaks

Right at the working face, a Texaco "Stop Loss" Program can help mine management plug many important profit leaks. Let Texaco help you organize your mine lubrication, train your personnel in proper maintenance practices and – by so doing – boost your tons-per-man rate and profit, too.

The money saved by bringing maintenance practices under control is a vital management concern – because every dollar saved in maintenance costs goes directly into profits.

Texaco "Stop Loss" Program, especially adapted for underground mining, can help you save money in practically every phase of your operation. For complete information call the nearest of the more than 2,300 Texaco Distributing Plants, or write: Texaco Inc., 135 East 42nd St., New York 17, N. Y.

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LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

intendent should have, be sure to pass it along through the mine foreman. If you have something to tell the mining-machine crew, tell the operator, not the helper. Later on it may be possible to take liberties with these channels but, for the new boss, taking such liberties only results in confusion and perhaps hard feelings.

• **Organize your total job and your tasks,** step by step. The block diagram at the head of this piece is one way of showing how you are related to job demands, responsibilities and authority. You can prepare similar pictures to pin down the details of work you are planning to have done. You would be well-advised to adopt the habit of keeping a notebook in your pocket. After some experience you will be able to remember a great volume of detail, but detail has a way of slipping from the memory of a man in a new job.

• **Learn as much as you can** as soon as possible about the men in your crew and their skills. Remember, you are a coach; know what your players can do. It is important also to learn as much as possible about the functions and limitations of the machines in your section—and about natural conditions.

• **Think long and hard before you make decisions.** You may rest assured that as a supervisor you will be called upon to make decisions, sometimes in rapid-fire succession. Frankly speaking this is the main reason for hiring supervisors. Wherever work is being done by a number of men there must be some one man who decides what to do and what not to do. As an experienced mining man, you will make proper decisions if you take time to think. You can be confident that you have enough knowledge to take the proper action in your sphere of supervision. So take a deep breath to relieve your nervousness, take a good look at the problem facing you, then do your best to come to a decision you won't have to change.

• **Get off to a good start even on rainy Monday mornings.** A grumpy supervisor can place his entire crew in the doldrums if he shows up at the mantrip wearing a long face. It is doubly important for the boss to leave his personal problems behind him when he enters the property. He carries too much responsibility. Decide for yourself that this new job of yours must have your undivided attention, and that you must show up for work every day clear-headed, alert and reasonably enthusiastic.

• **Concentrate on your job with all seriousness.** Sometime later you may be able to get away with light banter with the men, but be sure you know your men first. You will gain their respect only through good supervision, not through good fellowship. Therefore, devote all your effort toward becoming a competent leader of mining men. You can be pleasant without striving to be all things to all men.

• **Show by your attitude** that you are in solid agreement with company aims. You should have settled this agreement in your own mind before you accepted the job. You can dissent, but be sure your dissent is worthwhile and constructive. Don't rant against company policies in front of the men who work for you. You lost your privilege to climb onto a soapbox when you became a boss.

Attitudes and Actions To Be Avoided

• **Don't throw your weight around**—your new title doesn't really make you a supervisor. You will have to prove your right to the title by (a) building a record of being right on the majority of your big decisions, (b) building a good safety record based upon your skill and your concern for safety and (c) building a healthy production record on your ability to direct the use and maintenance of machines, motivate men, control costs and promote efficiency.

• **Don't sign your name** until you fully understand what you are signing. Under mining laws your signature does carry weight, so be certain to use it wisely. Until you become familiar with standard forms, sign all documents as though they are the fireboss' book. And your chalk-written initials in the places you visit are just as sacred as your signature. They tell the world that you have been here, that you have seen what is going on and that to the best of your knowledge everything is all right.

• **Don't compete with the men in doing the jobs** for which they are paid. You don't have to be the best workman in the section, you should be the best supervisor. If you see some project being done in an improper manner, don't feel that you must take over the tools to get the job done right. Actually, this is an opportunity to provide some training, and training is one of your proper responsibilities, as the block diagram shows. Furthermore, taking over the tools may end in embarrassment for you if you botch the job.

• **Don't let arguments about politics or other such matters take up your valuable time** in the mines. You may have strong opinions in these affairs and it may take quite a lot of effort to stay out of the discussions, but stay out you must. Otherwise you will be making antagonists for yourself at a time when you should be convincing others only of your ability to supervise the production of coal. You have enough to occupy your mind in the minute-by-minute duties of your job.

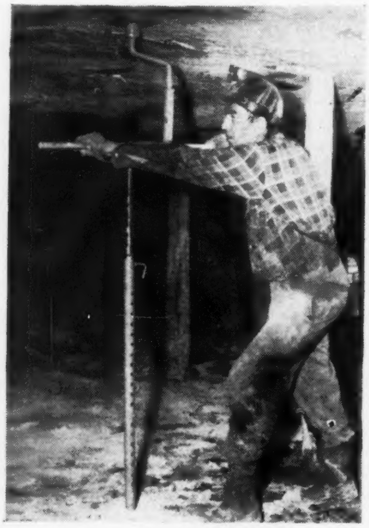
• **Don't be "thin-skinned" when criticism is directed at you.** Miners are renowned "kidders," and they may keep after you if you show that the jibes disturb you. For the first few weeks you may have some bad moments, but if you will take it with a level head they will soon tire of the sport. Criticism from your superiors is necessary to your development as a boss. Learn from it, don't resent it.

• **Don't pass the buck.** This is perhaps the worst habit you could possibly develop. You are a responsible man. No one cares to hear all your reasons for failing to get a job done, nor how someone else failed to keep their end of a bargain. The big hazard, however, is that you soon begin to believe the alibis yourself, thus limiting your ability to profit from your own mistakes.

• **Don't expect your job to become easier** once you have passed through this initial phase. The picture is constantly changing, and you will never see a time when a mine supervisor can lie back and let the job run itself. Right now the industry is changing more rapidly than it ever did. There is so much to be learned that the good boss will not hope for relaxation. This does not mean that you must operate in a constant sweat. It does mean that since you have chosen mine supervision as a career, you should be willing to keep abreast of what is going on in the industry.

• **Don't be discouraged by the setbacks** which are certain to come to you, one right after another sometimes. There will be times when you can't seem to do anything right. The only remedy is to bear down harder. At times like this it pays to take personal inventory. Most of the problems can be solved with your own talents and resources, and with the help you can have for the asking within your own organization. Your superiors want you to succeed. They don't like to admit they were wrong in selecting you for your job.

Operating Ideas



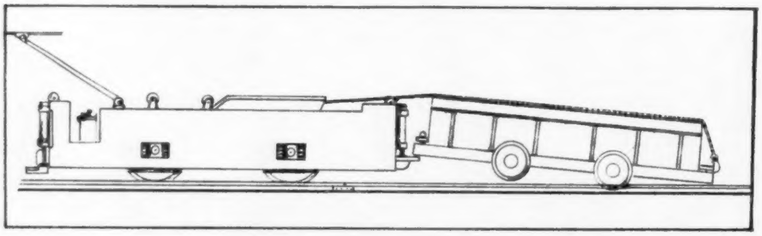
Post-Mounted Wrench Simplifies Bolt Recovery

ROOF-BOLT RECOVERY is simplified with the aid of a post-mounted wrench at the Glen Castle mine of the Hanna Coal Co., Cadiz, Ohio. The wrench has a telescopic leg which can be easily adjusted to fit the height of the opening.

In using the wrench, a worker places the socket over the bolt head, makes certain that the base rests on solid bottom and then tightens a set screw on the telescopic leg. With the wrench thus held solidly, the worker's hands are free to turn the wrench with two extension arms located about 18 in from the end.

Two specialists, who have been trained in safe bolt-recovery procedures, are employed regularly in recovery work at Glen Castle. These men recover 95% of all bolts for reuse. One man sets safety timbers in the area where bolts are being recovered and the other uses the post-mounted wrench to loosen bolts.

After a bolt is removed it is placed in a hand cart, the threads are oiled and a new Pal nut and expansion shell fitted on it. After 25 to 30 are recovered, the men pull the cart to an active working section and unload them for reuse. If a panel is on retreat, bolts are left at the room necks for removal.



Service Car Handles Heavy Equipment

A SERVICE CAR, designed and patented by Truman P. Mooney, fireboss at Eastern Gas & Fuel Associates Koppers-ton No. 2 mine, is a handy machine for retracking wrecked haulage equipment and moving mining equipment, according to *The Safe Mine Foreman*. Dubbed the "Moonix Service Car", the unit has two hydraulic jacks on each end of a locomotive and incorporates a hoist and strategically placed sheaves.

Mr. Mooney says that track haulage wrecks can be cleaned up quicker and faster with his car than by conventional methods. Furthermore, the machine saves time and effort in hanging, stretching and installing heavy cables. It is useful in moving rectifiers, generators, big pumps, elevators, belt drives and large rolls of belt.

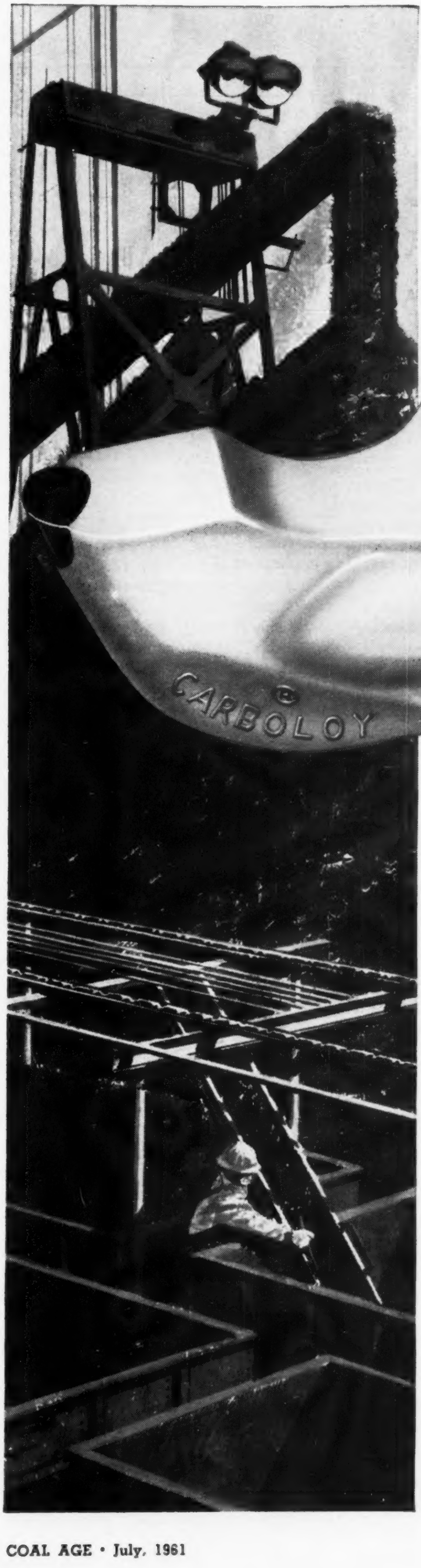
The locomotive can be locked in place by lowering rail clamps, which grab under the ball of the rail and hold the motor stationary. This feature prevents the motor from sliding on the rails, tilting or being raised off the track.

The hydraulic jacks can be dropped as much as 2 in below the rails, can catch under the bumper of wrecked equipment and lift it high enough to place it on the track. With the aid of the hoist rope, the wrecked equipment can be pulled in any direction. When wrecked equipment is beyond the end of the track, the hoist and rope can be used to bring it within reach of the jacks.

With the use of more large mine cars and roof bolts, more and more haulage wrecks are being retracked by using a rope through sheaves attached to bolts. The "Moonix Service Car" is said to be particularly suitable for this work.

Both ends of the motor are equipped with hydraulic jacks and sheaves and the car is serviceable from either end. When the rope works back over the deck of the locomotive, the hoist must be operated from the controls which are on the side of the machine. This arrangement prevents the operator from sitting in the deck and pulling equipment or material on himself.

Serving as sales agent for Mr. Mooney is the Kessler Sales Corp., Freemont, Ohio.



If you're looking for a bit at a bargain... DON'T!

Bit illustrated: CC-9

They cost you more than they save every time!

In mining, quality is the keyword. That's why it's so important to choose equipment and components that do the job you expect. In machine bits, that spells Carboloy ®.

Carboloy machine bits for coal mining give you higher tonnage output, last longer. And you can depend on Carboloy bits to be of the highest uniform quality order after order. No guesswork here!

Get the output only Carboloy mining bits can give you. Check with your Authorized Carboloy Mining Tool Distributor, today. He carries complete stocks of all Carboloy machine bits. And there's a Carboloy engineer nearby to assist you. *Metallurgical Products Department of General Electric Company, 11120 E. 8 Mile Road, Detroit 32, Michigan.*

APT STYLE

2-Prong Roof Bit—Cuts straight, clean, on-gage holes fast in medium formations. Longer tool life.

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Roof Bit—Solid insert. Tipped with wear-resistant carbide for maximum footage between regrinds.

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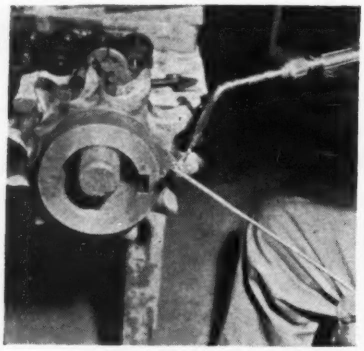
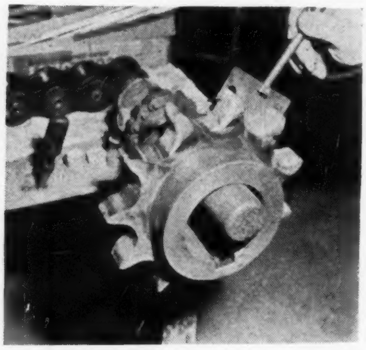
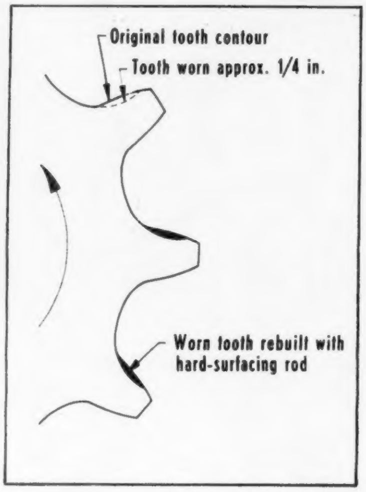






Hard-Surfaced Sprocket Teeth Require No Finish Grinding

WORN TEETH on the drive sprocket of a chain-driven conveyor are being successfully reclaimed by hard-surfacing. The conveyor transfers refuse from a separator in the preparation plant to the refuse pile.

Exceptional control of tooth contour is reported to be possible by using Colmonoy No. 6 hard-surfacing alloy. As a result, finish grinding is eliminated and the reclaimed sprocket can be used in the "as-welded" condition. Furthermore, the hard-surfaced sprocket lasts five times as long and costs one-third as much as a new sprocket.

New drive sprockets are fabricated of low-carbon steel plate. Exposure to coal dust and metal-to-metal contact with the link-type chain rollers causes severe abrasion and wear. Unprotected sprockets usually last about 8 mo. after which each tooth is worn approximately ¼ in.

Hard-surfacing is performed by Alloy Hard-Surfacing Co., Greensburg, Pa. Colmonoy No. 6 rod, ¼-in diameter, is applied to the worn sprocket teeth by oxy-acetylene welding as shown in the photograph.

A special template, shown in an accompanying photograph, is used to check tooth contour after welding. Smoothness of application of the alloy is reported to make it simple to control accurately tooth contour during welding. The rebuilt area can be readily reshaped, however, should the overlay fail to match the template. The alloy material is readily repuddled and can be formed while in the plastic state which occurs over a broad temperature range.

Another feature of the hard-surfacing material is its low coefficient of friction, which results in reduced wear in the link chain rollers and has cut chain maintenance cost.

Cooling Hot Spots

COAL STORAGE PILES frequently are plagued by fires caused by spontaneous combustion and many methods have been employed to put them out. Three supervisors at the Dow Power Department came up with this unusual method for controlling and possibly eliminating these hot spots in stored coal.

They take a section of 3-in pipe, slit it at one end and cut out wedges to form a point. Then they drill holes along the pipe length and thread the top end to receive a cap.

Next, they fill the pipe section with dry ice and drive it into the hot areas. The dry ice delivers a one-two punch. First, it cools the coal around it. Then, as it changes into a gas it filters through the coal, forming a blanket of carbon dioxide to smother any remaining fire.

Tappet Tips

REINSTALLING a tappet in the same tappet bore from which it was removed is an important procedure, reminds the service department of International Harvester Co.'s Construction Equipment Division. This method is recommended because each tappet, following a few hours operation, forms a compatible wear pattern in relation to the camshaft and its tappet bore.

Should a tappet be placed in the bore of another tappet, a different wear pattern must be formed at the camshaft. This condition can result in early camshaft or tappet scuffing and wear.

When installing tappets, follow these procedures:

1. Coat the cam lobes with S. C. I. heavy-duty axle lubricant before the camshaft is installed in the engine. This will provide initial lubrication and prevent cam-lobe scuffing when the engine is started.
2. Reinstall the tappets in the same bore from which it was removed.
3. Complete the engine assembly.
4. Run the engine at 1,000 rpm from 3 to 5 min after it is started. At this speed, tappets are under lighter load and initial lubrication will be assured.

When a tappet is removed and the tappet face is badly spalled, extreme wear can be expected in the cam lobe. A new camshaft should be installed.

ANACONDA makes an A-C CABLE for every mining operation

For primary distribution to high side of transformer: Anaconda SH-D cable. Conductors are insulated with Anaconda AB butyl for improved resistance to heat, water, ozone, aging and compression cutting. Anaconda designed rubber-cores cushion the ground wires, help prevent breaks from kinks and runovers. Exceptionally tough, abrasion-resistant neoprene jacket.

For secondary distribution from low side of transformer to power center: Anaconda Type PG or PCG cable. Precision stranding provides excellent bending and flexing properties. Insulation resists thermal overloads and aging. Special two-layer neoprene jacket, with a tough seine-twine web between layers for extra reinforcement, is highly resistant to rock-cutting, impact, slams, corrosive mine water, oil and grease.

For A-C Shuttlecars: Anaconda 3/C Flat Type G-600-V Shuttle Car Cable. Flat construction assures maximum crush resistance and easy reeling. Shaped insulation minimizes mechanical damage because phase and grounding conductors can't shift in use. Power and ground conductors specially engineered to resist bending and flexing fatigue. Color-coded neoprene insulation and neoprene jacket are compounded for toughness, heat stability and crush-resistance. Rubber-coated nylon breaker strips provide extra protection against phase-to-phase shorts. Nylon seine-twine reinforcement gives high tensile strength.

For high-voltage distribution: Anaconda 3/C 5-Kv Mine Power Cable with Ground Check. Anaconda AB butyl insulation meets or exceeds all industry standards. Anaconda's specially blended AB butyl insulation also gives superior ozone resistance, low mechanical moisture absorption, stable power factor under daily load cycles, greater heat dissipation, and superior aging characteristics. Strand shielding provides uniform stress distribution. Neoprene jacket resists abrasion, oil, grease, mine water and alkalies. Recommended for 90C maximum conductor temperature up to 5000 V; 85C maximum at higher voltages.

For further information on any of these cables, or any other type of mining cable, contact Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York, Department EFL-1-CA

61257

COAL AGE

New Equipment News

Truck Delivers 32-Ton Payload

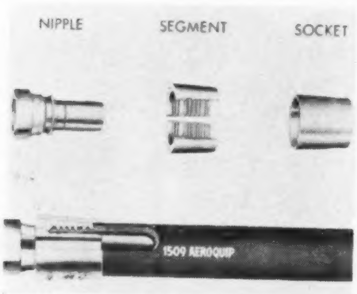
High-tensile-strength steel has been used extensively throughout the body and frame of the Model 32S. Thus, the parasitic weight of this truck is reduced to a minimum.

It will deliver a payload of 32 tons on a short wheelbase, making it highly maneuverable. Empty, it weighs 44,675 lb. Tires are 18:00x25 and 24-ply all around. The Model 32S employs a Cummins V8-350, 350-hp diesel engine and a unit-mounted, heavy-duty transmission providing 10 forward and two reverse speeds. Torque converter is optional. Offered by KW-Dart Truck Co., 1301 N. Manchester Trafficway, Kansas City 20, Mo.

Articulated Pusher-Dozer

Latest addition to the "Paydozer" line of Frank G. Hough Co., Libertyville, Ill., is the Model D-500 pusher-dozer, weighing more than 100,000 lb.

A most unusual feature of this machine is the full hydraulic-articulated steering which is said to provide exceptional maneuverability. The turning radius of this unit is 25 ft which is less than its overall length. When employed in conjunction with a scraper for push-loading, this articulation, combined with rear-axle oscillation, enables the D-500 to easily "walk-out" of soft ground with a unique twisting motion. Unlike conventional rear-wheel-steer units which have a tendency to crawl up the side of the cut being made, the rear wheels track with the front, even in sharp turns.



New Hose Fitting Concept

"Iron Mike," a new type of detachable, reusable fitting for high-pressure hose assemblies, has been developed by Aeroquip Corp., Jackson, Mich.

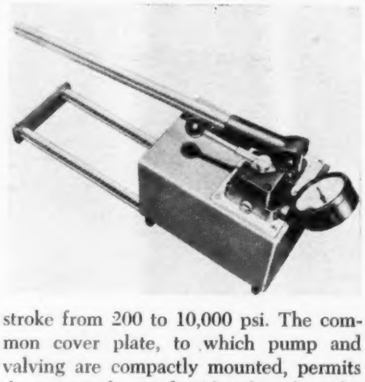
Basically, "Iron Mike" consists of three components: (1) a tapered steel socket which is "pushed" over segments during assembly and forms a rugged compression fitting that won't blow off; (2) two aluminum segments which grip hose reinforcement securely, and mate with nipple assembly for correction positioning; (3) a steel nipple (has no threads) which fits into hose and does not cut hose inner tube. The variable component is the nipple which is supplied in the 10 different end styles.

"Iron Mike" fittings have been designed for hose sizes ranging from ¾ to 2 in, and especially for use with Aeroquip 1509 high-pressure hose. The 1509 hose used with "Iron Mike" is suitable for operation in temperatures ranging from −40 F to +200 F, and for use with hydraulic fluids, crude oil, fuel and lubricating oils, gasoline and air.

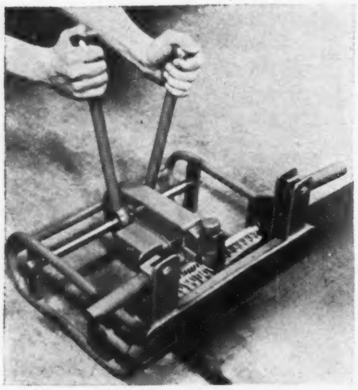
Two-Speed, High-Pressure Hydraulic Hand Pump

This fast-acting, two-speed hydraulic hand pump not only handles high-force, high-pressure requirements up to 10,000 psi, but delivers very high volume at low pressure (7.35 cu in per stroke from 0 to 200 psi) to quickly move the piston to and from the work. Weighing only 34 lb, the "Dualmaster" measures 26½ in long, 8 in wide and 12 in. high.

When a load is encountered, the new pump automatically changes to the high-pressure stage, delivering .294 cu in per



stroke from 200 to 10,000 psi. The common cover plate, to which pump and valving are compactly mounted, permits the unit to be used with other than the standard OTC reservoir. And a versatile mounting pad on the plate accepts either 2- or 4-way valves for controlling single- or double-acting cylinders. Owatonna Tool Co., 652 Cedar St., Owatonna, Minn.



Zipper Eases Belt Splices

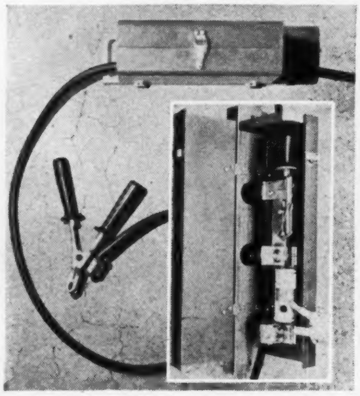
The Hayden Zipper (photo) is a new type of portable, one-man splice maker for conveyor belts. Adaptable to all belt thicknesses, width and types, the Zipper is a fully portable, lightweight unit which can be used with ease in seams as thin as 20 in. It has a transport height of 9¼ in and a vertical working height with operating levers extended of only 16 in.

A companion product is the Hayden long-reach hook which grips the belt carcass far back from the edge of the splice. Combined with the Zipper's 7-mm hook spacing, the improved hook construction is said to afford sturdier, longer-wearing splices for belts of all thicknesses.

Three hook types used with the Zipper cover the range of belt thicknesses, without adjustment of the machine. National Mine Service Co., 2530 Koppers Bldg., Pittsburgh 19, Pa.

Power Box Protects 600-Amp Circuits

Low-cost 600-amp fused protection is offered in a new device called the Fused Power Box announced by Ohio Brass Co., 380 N. Main St., Mansfield, Ohio. Two types are offered. One is designed for easy carrying from job to job while the other (inset) is intended for wall-mounting and has a built-in switch for cutting the circuit during fuse changes. The portable unit accomplishes this by being de-



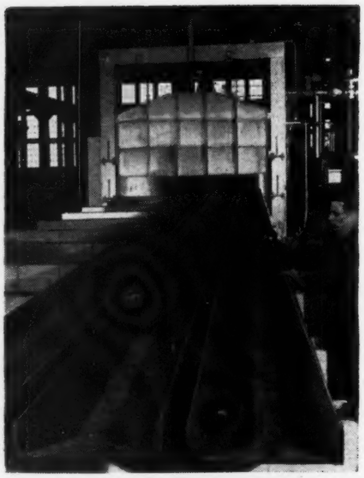
tached from the power source during the fuse change.

Both types are designed for heavy-duty mining applications and, since they share all major components, many parts are interchangeable. A compact glass-fibre case encloses and isolates the working parts and the two-piece case hinges from the metal base allowing plenty of working room. All current-carrying parts are insulated from the metal base by patented Dirigo Insulators. The unit's cartridge fuse is the renewable-link type. And a variety of connectors are offered.

Alloy Steel Shapes

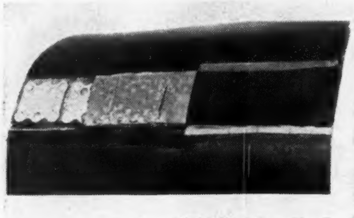
The first commercial production of rolled structural shapes made from quenched and tempered alloy steels has been announced by U. S. Steel Corp., 525 William Penn Pl., Pittsburgh 30, Pa.

Heat treated to a minimum yield strength of 100,000 lb per sq in, or as much as three times that of structural carbon steel, the new shapes are said to promise important wieight and cost savings in a host of structural applications. Final step in the heating cycle is a tempering treatment which follows the water quench. Photo shows worker



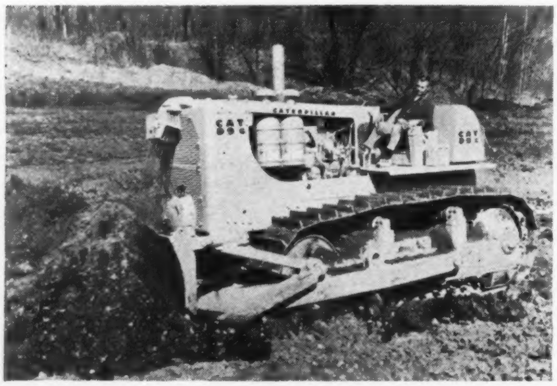
checking quenched channels of USS "T-1" constructional alloy steel for straightness before they enter tempering furnace.

Furnished in standard I-beams, channels and angles, and in lengths up to 40 ft, the new shapes are produced from several of the company's best known quenched and tempered alloy compositions. U. S. Steel sees a major market for these shapes in machinery and equipment, especially mobile types. Here, the prime object would be to carry the biggest possible payload with the least amount of dead weight.



Rubber Covered Belt Splice

A new method of belt joining has been devised by Crescent Fastener Co.



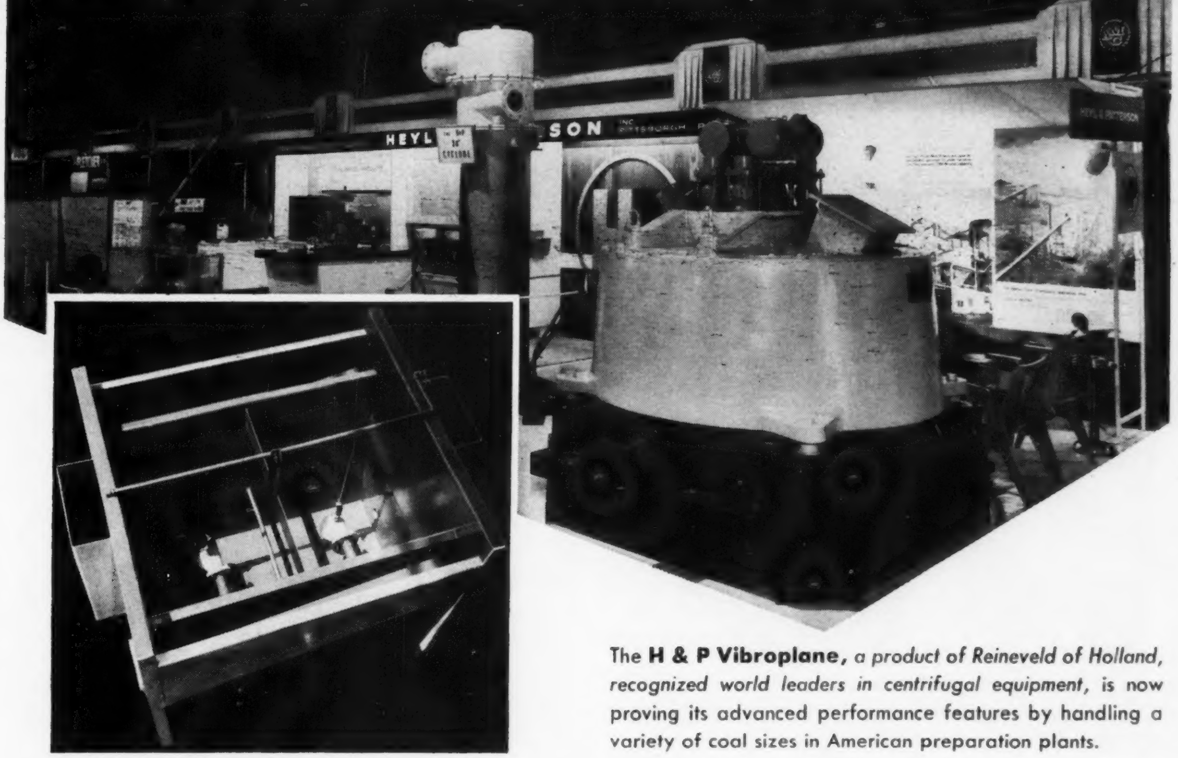
Tractor With Power Increase

With 385 hp and an improved, more efficient torque divider power-shift transmission, the Cat D-9 Series G tractor is job-matched to a wide range of heavy-duty applications. Controlled turbocharger and aftercooling of intake air contributes to the 15% horsepower increase. In addition, development of a slip clutch for the fan drive also helps increase usable horsepower by reducing, by as much as 30%, the power absorbed in driving the engine fan. It is the first time these innovations have been incorporated into crawler tractors, reports the manufacturer, Caterpillar Tractor Co., Peoria, Ill.

Three new, hydraulically-boosted cable controls are offered for the D-9G. All have larger clutches, brake and drum capacities. Also nine separate arrangements of hydraulic controls, from three basic units, are available. Details from the company.

New H&P Headliners for Better Coal Preparation...

It virtually required a "double feature" to introduce all the new Coal Preparation Equipment recently added to H&P's line of proven values.



The new **H & P Cyclo-Cell** for froth flotation, *received with unusual interest,* has a novel hydro-pneumatic principle of operation which permits unequaled simplicity of design and offers these outstanding advantages:

- No moving parts in the Cell, yet more aeration and agitation.
- Combination of high recovery and exceptional ash reduction.
- Low operating cost.
- No mechanical maintenance in the cell.
- Ease of installation.

For truly superior performance select H & P Cyclo-Cells—the newest product of Heyl & Patterson's engineering skill, backed by years of experience in creating better preparation equipment for the coal industry.

The **H & P Vibroplane,** *a product of Reineveld of Holland, recognized world leaders in centrifugal equipment,* is now proving its advanced performance features by handling a variety of coal sizes in American preparation plants.

The New H & P Vibroplane:

- is designed to handle large tonnages *(in actual operation, the feed rate exceeds 100 TPH).*
- is capable of handling a wider range of coal sizes—*(for instance 3/8" x 0* without desliming, *also stoker sizes, or anything in between).*
- has higher G-forces and greater screen surface area—therefore must produce consistently a product with lower moisture. *(Surface moisture in stoker sizes approaches the 2% mark; 3/8" x 0 product heavily loaded with fines minus 28M is dried below 10%).*

Other outstanding features are the high rate of recovery, low power requirements, and the low rate of degradation.

The H & P Vibroplane—a Coal Drying Centrifuge for the widest variety of jobs, belongs in the preparation plant where only the best all-around performance will do.

For proof, call in your H & P Contracting Engineer.

Other familiar H & P Preparation Equipment:

The H & P Cyclone
The H & P Sieve Bend
The H & P Fluid Bed Dryer
The Reineveld Fine Coal Dryer

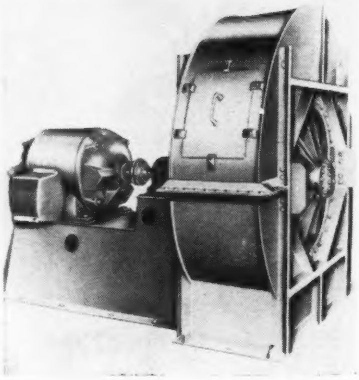
H&P

HEYL & PATTERSON, inc.

55 FORT PITT BLVD., PITTSBURGH 22, PA.

Inc., 381 Fourth Ave., New York 16, N. Y. With this method, an average belt can be mechanically spliced and moisture-proofed, in 1½ hr. After a simple counter-sinking operation, rugged Crescent Belt Plates are speedily attached and then covered with a rubber strip. The result is a joint that prevents fabric rot due to moisture, a cleaner scraper operation and elimination of wear on idler rollers. Photo shows plates attached after removal of the rubber cover, rubber filler stock over the plates and rubber patch covering plates and filler.

Fans With Airfoil Blading



A new series of heavy-duty industrial fans feature the use of airfoil blading. Tailored specifically for high efficiency at direct-connected motor speeds, the Series 8500 centrifugal fans are consistent with an industrial trend to direct-drive-type machinery because of its reliability in continuous operation. The units are offered in five AC direct-connected motor speeds—1,800, 1,500, 1,200, 900 and 750 rpm—with capacities from 15,000 to 450,000 cfm. Bearings are integral with the fan unit and the motor, or turbine, is direct-connected to the fan shaft through couplings. An optional accessory is an adjustable inlet spin vane control. Westinghouse Electric Corp., Sturtevant Div., Dept. T-292, Hyde Park, Mass.

No Clogging with New Vibrating Screen

"Umbra" screeens are said to give excellent performance when used for wet

Tractor-Scraper Matches Job Conditions

Automatically matching power-to-job conditions, the 619C tractor-scraper, with 280 maximum hp, has been introduced by Caterpillar Tractor Co., Peoria, Ill. Major features include 18-cu yd heaped capacity, an all-new-design turbocharged engine, 30-mph road speed, effort-saving, air-actuated cable control and unitized construction.

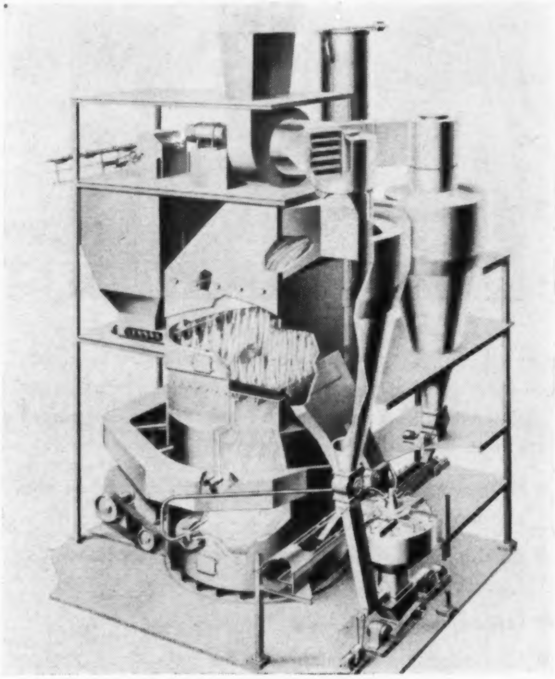
The exclusive torque-divider power-shift transmission provides nine speeds with only three operator "shifts." As load resistance is overcome, the transmission automatically shifts within each speed range from torque-divider drive to direct drive to over-drive. Downshifting also is automatic in each range. To develop maximum rimpull at pusher matching speeds for fast loading, the unit can be locked in torque-divider drive.

Combustion Chamber Inside Thermal Dryer

McNally "Flowdryer" units, designed in various sizes, are adaptable to the size of feed varying from 1¼x0 to 10Mx0. A single unit can handle 25 to 500 tph of product with 3 to 36 tph of evaporation.

Here is how it operates: A series of paddle-type mixing screws, which thoroughly mix filter cake and centrifuge product, feed the wet coal across the entire width of the drying chamber. From there each particle progresses with nearly equal velocity across the drying screens to the discharge point.

The combustion chamber is a vertical cylindrical fire box with pressurized, pulverized fuel burners located around the periphery at the base. Tempering air is introduced under pressure around the periphery approximately midway between the burners and the grate.



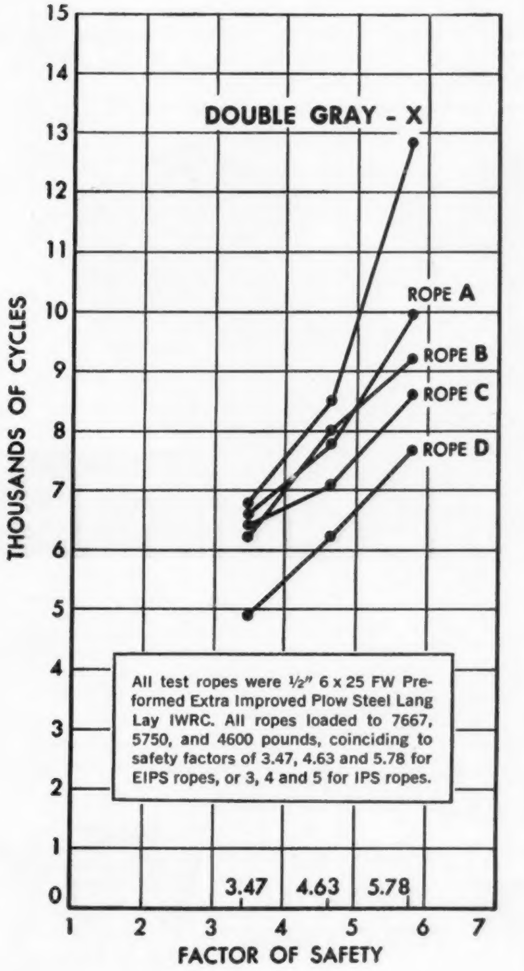
The Flowdryer uses an overall high-pressure system by dividing it between two relatively low-pressure fans that are neutralized in the coal bed. With this method of fluidizing, a minimum pickup of fines results. Also, difficulty in sealing the coal feed opening and product discharge area is greatly reduced. Use of two fans permits a very high evaporating capacity with lower motor horsepower requirements. A constant flow rate of gases is maintained through the coal bed for proper fluidization. Maintaining a constant low exhaust temperature varies temperature of the drying gases to suit evaporation requirements. Any malfunction of power failure results in a "fail-safe" situation through reliable automatic controls. McNally Pittsburg Mfg. Corp., Pittsburg, Kan.

DOUBLE GRAY®-X lasts longer

Tests prove CF&I-Wickwire's premium wire rope has 45%* more bending life than average of other ropes tested

In an extended series of tests conducted at CF&I's Palmer Plant, five brands of wire rope were tested to destruction on a 25,000-pound fatigue machine that bends wire rope back and forth over sheaves until it breaks.

All the ropes tested were made by major manufacturers, and were identical in size and specification. And all exceeded the catalog-breaking strength of extra-improved plow steel rope. But, as the chart indicates, one rope outlasted all the others at every safety factor used in the test. That rope was Double Gray-X!



At the highest and most commonly-used safety factor, CF&I-Wickwire's premium wire rope lasted 30% longer than the rope that survived next longest, and 68% longer than the rope that lasted the shortest length of time. Double Gray-X lasted 45% longer than the average of all other ropes tested at this safety factor.

Double Gray-X has greater resistance to bending fatigue, the chief enemy of wire rope life, because it is the result of a breakthrough in wire-drawing technology. The use of molybdenum disulphide in the drawing process produces these outstanding fatigue-resistance factors:

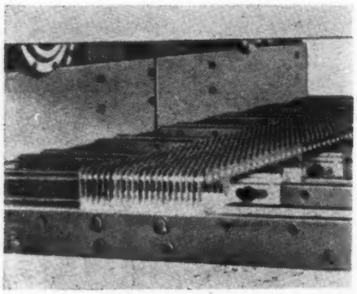
- A Molecular Shield . . . which prevents the wires from grinding together as the rope operates.
- Smoother Wire Surfaces . . . providing better resistance to fatigue.
- Extra Toughness . . . because molybdenum disulphide helps preserve the inherent toughness of the wire during drawing.

Double Gray-X can save you money because it lasts longer on even the most punishing jobs, as proved by these tests and by field reports from satisfied users. This longer-lasting wire rope cuts repair and replacement costs, lowers your total wire rope investment and reduces machine downtime. Use the wire rope of *tomorrow* today! Ask your CF&I salesman for complete details.

*Percentage above average of all other wire ropes tested at safety factor of 5.78.

CF&I STEEL MADE IN U.S.A.

The Colorado Fuel and Iron Corporation
Denver • Oakland • New York
Sales Offices in All Key Cities



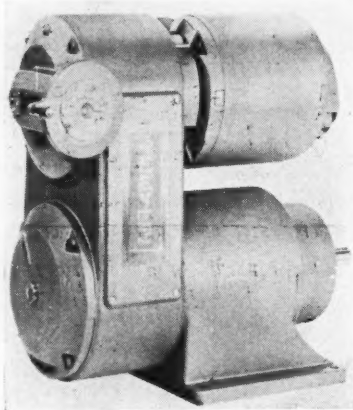
screening, desliming and dewatering of granular materials. One of the most important features of the screen is the efficient screening of solids with surface moisture far beyond that normally considered practical—with clogging. It is capable of handling ¼x0 to 4x0 coal. The screen deck (photo) is composed of individual panels which facilitates easy assembly and replacement.

McNally Pittsburg Mfg. Corp., Pittsburg, Kan., acquired the "Umbra" screen from Victor Halstrick, KG. Herne, Germany.

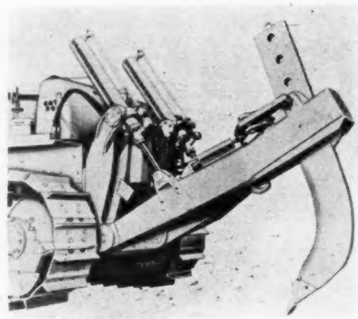
Variable-Speed Motor Drive

The Reeves variable-speed Motodrive, complete with single-, double- or triple-stage gearing, provides speed ratios up to 4:1 and output speeds from 2,630 rpm to 25 rpm. Ratings from 25 through 40 hp are available.

The size 600 Motodrive provides over 100 different standard assemblies with



magnetic brakes up to 230-ft-lb capacity offered. And there is no extra charge for vertical, horizontal and 45-deg assemblies in wall or ceiling mountings. For no-reducer and single-reducer units, trunnion-mounted vertical, horizontal, 45-deg assemblies are offered as standard. And either "C" or "Z" flow output shaft arrangement is standard for all assemblies. Reliance Electric & Engrg. Co., 27401 Euclid Ave., Cleveland, Ohio.



Improved Ripper

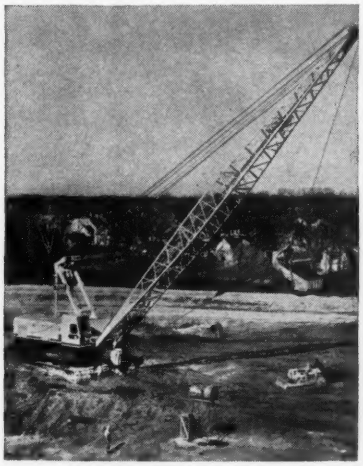
Greatly increased service life and a reduction in operating costs are claimed as a result of design improvements of the Kelly D9 Model C ripper. Integrally mounted, it can rip most any material including solid rock to depths of 84 in. Higher strength, higher-alloy steels have permitted a more-compact, lighter-weight unit while increasing wear resistance. And the new models, designed for use with the D9 tractor, are easier to install.

Both single- and triple-shank models are offered with a wide variety of shank types and boots. Double-acting cylinders, 7 in in diameter with 48-in stroke, control the welded box-section tool bar. Kelly Products, P. O. Box 2073, Houston, Tex.

Crawler Tractor

Newest member of the International construction equipment family is the TD-15 (151 Series) crawler. This crawler features in-built, gasoline-conversion, push-button, all-weather starting of the 4-cycle, valve-in-head type engine. A six-speed, full-reverse transmission, with six forward and six reverse speeds, operates with single-stick shifting.

Powered by 6-cyl International D-554 diesel engine, the tractor develops 105 engine hp at 1,650 rpm. Drawbar horsepower is 85, with the unit having a 23,750-lb maximum drawbar pull with adequate weight and traction. This series is offered in 74- and 62-in gage tracks. Shipping weight is 22,500 lb for the 74-in model and 22,150 for the 62-in version. International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.



Dragline-Clamshell Handles Buckets Up to 10 Cu Yd

With boom lengths of 100, 120 and 140 ft, the Model 210-B diesel-electric dragline and clamshell can handle buckets up to 10 cu yd. Key feature is the elimination of friction clutches for all cyclic functions.

Hoist and drag or holding and closing motions are regulated by a static control of independent electric eddy-current clutches, liquid cooled by a radiator system. The swing motion is controlled by a variable Ward Leonard system. Sales Promotion Div., Bucyrus-Erie Co., South Milwaukee, Wis.

Diesel Truck Hood Tilts Forward 90 Degrees

Two new series of conventional, diesel-powered trucks have been added to International's DCO-400 line. Designated the 400 Series models, these units are offered in D-400 front-axle-forward or DB-400 set-back front-axle design with weights to 79,000 lb gcw.

One design highlight of the series is the reinforced fiberglass hood and fender assembly which tilts forward a full 90


201

In NEBRASKA

Hauling 32-ton loads of overburden to dump area, LeTourneau-Westinghouse Haulpaks cruise along well-maintained roads at speeds to 38.8 mph. Safe? You bet! There's a total of 5,148 sq in. braking surface on 32-ton Haulpak . . . *four times* the braking area of most comparable-capacity trucks.

In INDIANA

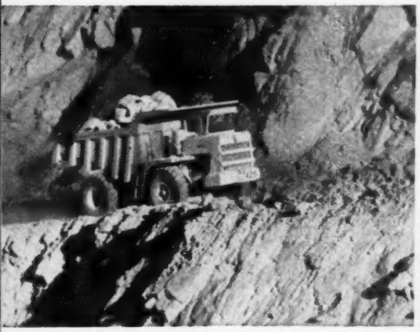
27-ton Haulpak highballs over typical quarry road. Hydrair® suspension cushions travel shocks . . . keeps load riding level, reduces spillage during high-speed haul. Center of gravity is *low*, because about 6 tons of material are carried *below* normal truck floorline in Haulpak's deep V-body.

In UTAH

Here's the big 550-hp, 60-ton Haulpak in action. This latest addition to LW line, carries almost *twice* its own weight in payload capacity! Weighs approx 66,000 lbs, carries 120,000-lb payload. Reason: high-tensile-strength steels, nearly 3 times stronger, ⅓ lighter than in ordinary trucks.

In CALIFORNIA

Heaped with rock, 32-ton Haulpak shows plenty of power and pep as it climbs grade. Pit-to-plant hauls are long . . . grades, steep and winding. Talking about acceleration and power, another LW owner reports: "Our Haulpaks come out of the pit in a higher gear, and at a faster rate of speed, than any unit we are familiar with."



In NEW MEXICO

Over-the-edge dumping minimizes clean-up on this waste bank. Notice how edge of bowl swings low, well back of rear wheels, as the body starts to raise. Dump action is fast, too! Twin hydraulic rams lift the body to full dump-angle in approx 16 seconds. LeTourneau-Westinghouse Haulpak shown below is 27-ton size.

In PENNSYLVANIA

Stripping contractor owns 4 of these LW 32-ton Haulpaks. Comparing them with conventional 22-ton trucks, contractor says: "Haulpak's short turn-around, plus high hauling speeds, mean that each of these 32-ton trucks gains one complete round trip in every seven on hauls of average length. Ours vary from 800 to 2500 feet."

PER TON-MILE for owners everywhere

In ILLINOIS

At this strip-mine, special *bottom-dump* Haulpaks carry 90 tons of coal per trip. Performance-proven since 1957, this giant LW hauler has: springless Hydrair suspension on all wheels, Hydrair trailer-hitch, Power-Transfer differential, and many other "firsts" in big trucks.

In NEVADA

This 60-ton Haulpak works around the clock, 7 days a week, on a mile-long haul. Average adverse grade: 7%. It's a grueling assignment, but LW Haulpak has the matched power, speed, and structural strength it takes to beat tough work schedules. Haulpak's production: 1668 tons per 7-hour shift!

Destination: LIBERIA

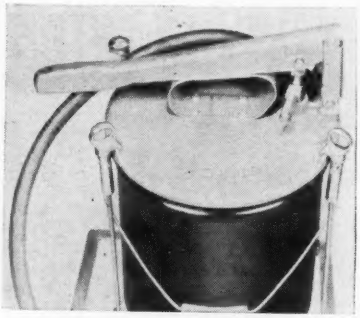
With 5 LW Haulpaks already at work, 7 *more* are on their way to a Liberian mine. Here's part of the latest 27-ton Haulpak fleet being readied for overseas shipment. In addition, the African mining firm has 2 LW 440 graders, and 9 C Tournapulls® building a railroad service line.

deg for easy accessibility to all front-end components. Other significant features include superior ride and handling characteristics, cab comfort and reduced chassis weights. Standard diesel engine for all models is a 180-hp in-line six with nine optional engines offered. Ratings range up to 335 hp. Details from International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill.

Redesigned Low-Voltage Motor Control Line

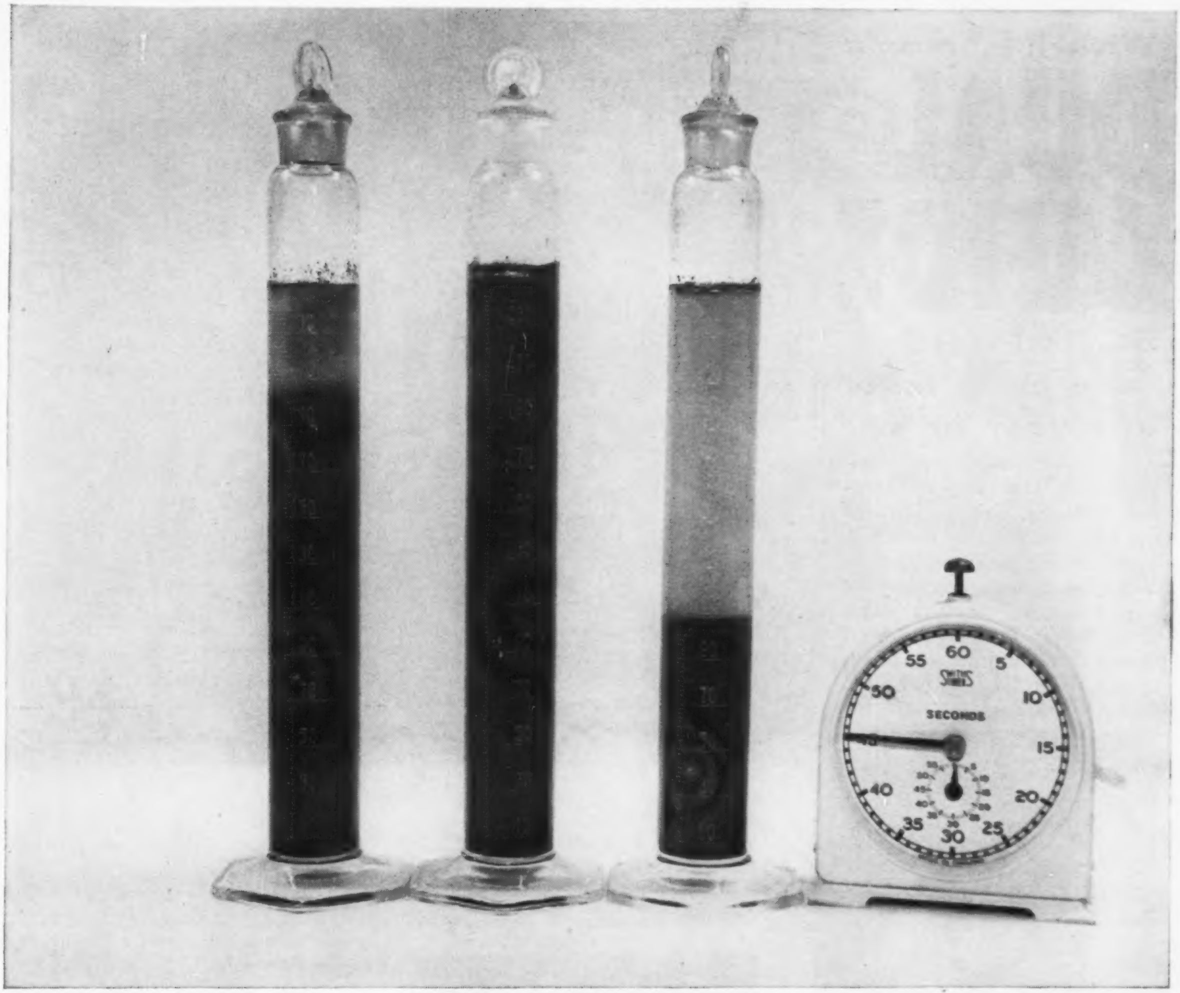
This line includes standard, special-design and accessory devices to handle industrial and commercial motor-control applications from 110 to 600 V for fractional to 200-hp motors.

Outstanding design feature of the line is unitized construction making possible the benefits of building-block modification for economical versatility. Drum controllers, explosionproof starters and starter-circuit breaker combinations are included. For complete information, write Allis-Chalmers Mfg. Co., 986 S. 70th St., Milwaukee 1, Wis.



Lubricant Pump

Alemite's Model 7138 VP pump delivers instant lubrication up to 5,000 psi at high-pressure setting or 1 cu in per stroke when high volume is required. Said to be actually two pumps in one, it has a lapped-fit high-pressure piston directly connected to the main pump rod and handle. And it operates within the volume pumping piston. Setting is



fast flocculation like this means clear overflow, high capacity, low cost

This photograph compares the settling rate of coal fines in water under three different conditions.

The center graduated cylinder contains coal fines and water without flocculant. There is no settling after 45 seconds.

The cylinder on the left contains starch, a material used for flocculation. There is some settling, but it is not nearly complete.

The cylinder on the right contains Separan® AP30. Notice that, after only 45 seconds, settling is nearly complete. In actual plant use, Separan AP30 has maintained clear water overflow under extremely difficult conditions.

Separan AP30 is producing settling rates of 20 to 25 feet per hour at concentrations of 0.01 to 0.20 pounds per ton of solids. Costs of 1½¢ to 3¢ per ton of solids have been reported by many plant operators. The cost of using Separan AP30 often has been only half the cost of the flocculant previously used.

With Separan AP30, many operators have been able to maintain clear wash water overflow at high plant rates without adding expensive new equipment – thereby keeping down capital investment.

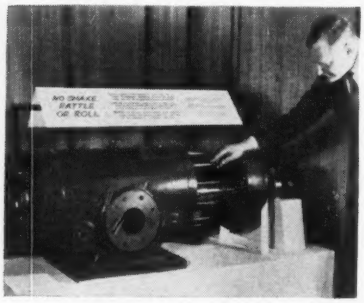
Many operators have already changed to Separan. If you have not, arrange for a demonstration at your plant right away. Just contact Dowell at 1918 Highway 41, North, Evansville 7, Indiana. The telephone number is HArrison 5-1353. Or, contact B. E. Scott at 197 Monterey Drive, St. Albans, West Virginia. His telephone number is PArkway 7-2895.

PRODUCTS FOR THE COAL INDUSTRY

DOWELL

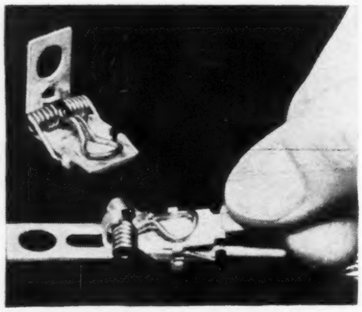
DIVISION OF THE DOW CHEMICAL COMPANY

changed by a flick of the finger. In addition, the new pump is weatherproof and easily portable. Alemite Div., Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago 14, Ill.



Smooth-Operating Compressor

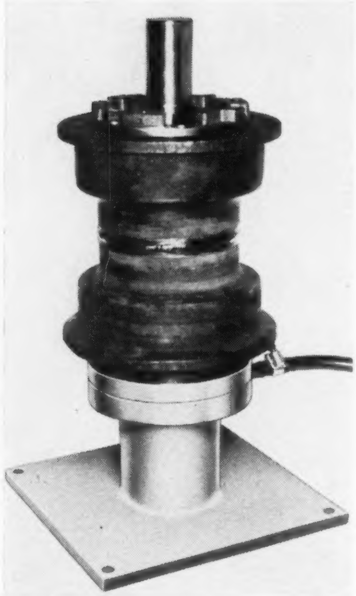
Vibration-free operation—no shake, rattle or roll—is claimed for the Ro-Flo rotary, two-stage air compressor. A supply of air pressure to 125 lb gage with volumes of 250 to over 1,800 cfm is offered at less cost with the rotary units. Maintenance requirements are reportedly reduced by the Unit's smooth operation and the rotary motion cuts vibration. In addition, self-adjusting blades with an average operating life of 2-3 yr, yield constant efficiency. Allis-Chalmers Mfg. Co., 986 S. 70th St., Milwaukee 1, Wis.



Quick-Disconnect Terminal Assembly For Brushes

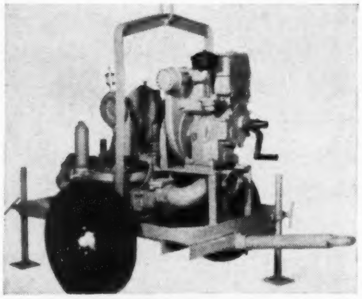
A new variation of its quick-disconnect terminal assembly for brushes is available from National Carbon Co., Div., Union Carbide Corp., 270 Park Ave., New York 17, N. Y.

In the original assembly (upper left) the clip was designed with a 90-deg bend. Now a straight clip is available and is better suited to certain electrical machinery. The new model has an improved, more-positive-acting stainless-steel spring for maximum resistance stability. A major advantage is that two spade terminals can be inserted in one clip.

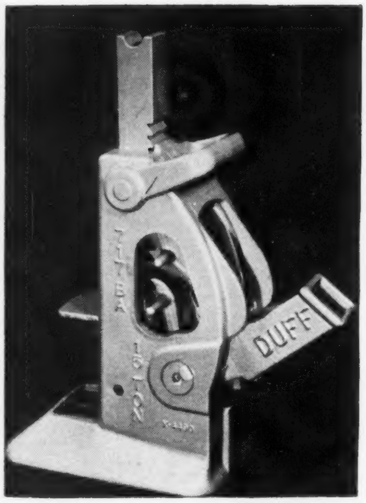


GREASE FIXTURES—A new greasing fixture (photo) for grease-loading Allis-Chalmers crawler-tractor truck wheels and track-idler assemblies which have solid shafts is available from Owatonna Tool Co., 652 Cedar St., Owatonna, Minn. Identified as No. AC-400, it consists of a basic stand used for all models and six special adapters to handle truck wheels and track idlers on HD-6, HD-11, HD-16 and HD-21 crawler tractors.

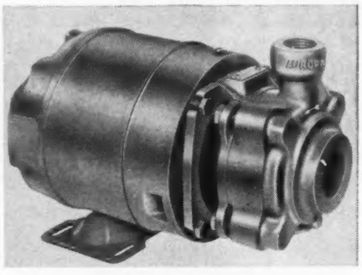
For quickly freeing frozen zirc-type grease fittings, Owatonna offers its hydraulic "Zirc-Ram." This new tool, No. 519, works on either straight or angle fittings with one hammer blow which generates up to 1,000 lb of hydraulic pressure. Fittings are not harmed since pressure is exerted by oil, not metal.



DIAPHRAGM PUMPS—Rice Pump & Machine Co., Belgium, Wis., has added to its line a series of four air-cooled, diesel-powered, self-priming diaphragm pumps. Capacities range from about 1,500 to 18,000 gph. The new line includes single- and double-diaphragm types with 2-, 3- and 4-in openings. The diesel engines are 4-cycle air-cooled, crank-start types, with electric starters optional.



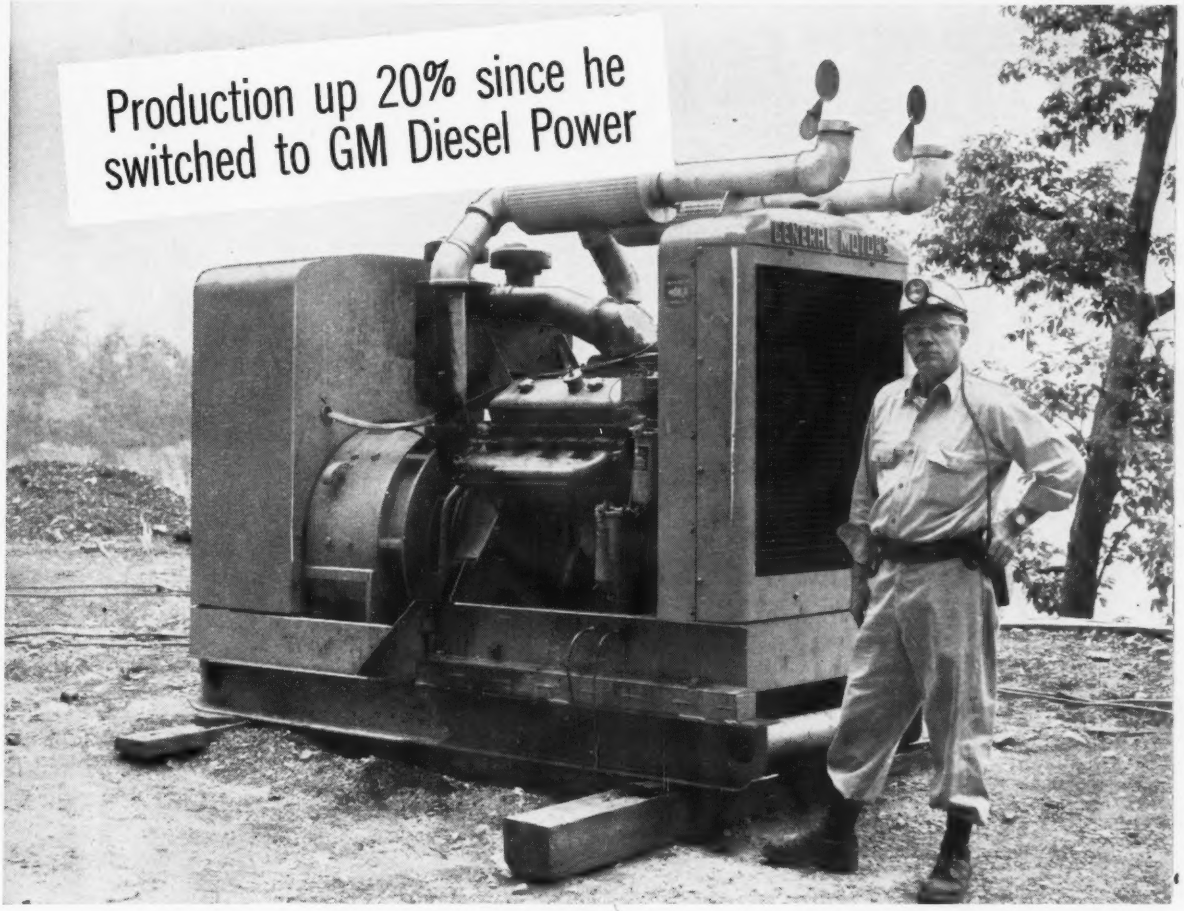
HIGH-LOW TRACK JACK—A 36-lb, high capacity, aluminum track jack designed for high or low operations has been developed by Duff-Norton Co., 4 Gateway Center, Pittsburgh 22, Pa. Capable of lifting 15 tons, it measures 6½ x 10¼ in at the base, 14 in high and has a raise of 7½ in. Foot-life height is 2 in and rack size is 1⅝ x 1⅝ in. With the exception of its rack and base, all parts of this Model 717-BA are interchangeable with six other Duff-Norton track jacks.



CENTRIFUGAL PUMPS — Reduced space requirements and faster, easier installation are outstanding features of the new packaged line of close-coupled, end-suction centrifugal pumps offered by Aurora Pump Div., New York Air Brake Co., Aurora, Ill. A size range from ¾x1 in to 3x3 in provides capacities to 400 gpm and heads to 150 ft. Vertical centerline discharge makes these pumps self-venting, eliminating the possibility of vapor locks and providing smooth-running operations with low noise level. The complete disassembly feature eases inspection and maintenance.

WIRE FEED UNIT—A wire feed unit for semiautomatic open-arc hard surfacing by welding is said to provide 2½ times the wire supply of the normal coil-type machine, with equal portability and weight. Combining the Weld-Pak as

GET REAL PRODUCTIVITY—GET A GM DIESEL



Production up 50 tons per day with no increase in fuel consumption.

Equipment slowdown because of sudden load increases ended—electric-motor overloading eliminated—downtime and equipment repairs cut...

That's what happened at Phillips Coal Company's Reedy Creek Operation in Pineville, W. Va., when they switched from a competitive Diesel to an 8V-71 "Jimmy."

The "8V-71" runs a 150 KW generator—furnishes all the power needed by a #512 hydraulic coal cutting machine, #14BU Joy loader, two 6SC Joy shuttle cars, belt line, chain line, and 5-foot ventilating fan. There's reserve power for additional equipment if it's needed, too.

Reedy Creek Owner-Manager Leonard Phillips says he picked a GM Diesel because of the job other "Jimmys" have done for him since 1954. He operates a Koehring shovel and two auger drills, powered by "4-71" GM Diesels—reports he's averaging four years between engine overhauls.

If you want to make more money from your mine, put a GM Diesel to work for you. See your GM Diesel Distributor for details. He's part of a coast-to-coast network of "engine people" you'll find in the Yellow Pages under "Engines, Diesels."

GM DIESEL

DETROIT DIESEL ENGINE DIVISION, GENERAL MOTORS, DETROIT 28, MICH.

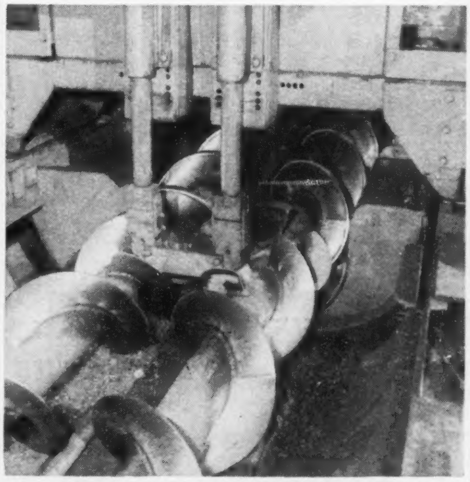
In Canada: GENERAL MOTORS DIESEL LIMITED, London, Ontario
Parts and Service Worldwide

GM DIESEL ALL-PURPOSE POWER LINE sets the standard of Diesel productivity

DUAL COAL AUGER

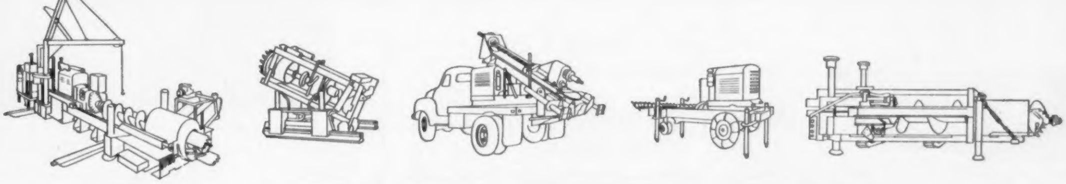
increases profit...
mines low seam coal...
increases recovery...

AUTOMATIC COUPLING AND UNCOUPLING OF AUGERS take place from operators' positions by means of automatic latches. Machine positions augers for fast coupling.



Salem's powerful, new Dual brings low seam coal into the profit class by increasing practical boring depth to 200 feet (100% increase over previous equipment), handling augers from 18" to 30" diameter with only minor machine adjustments, and cutting straight and true in seams only inches thicker than the augers. Coal feeds back along both augers, maintaining the consistency of the size cut. Coal is cleaner and recovery is 50% higher. Your profit is higher. The Dual, like all Salem coal augers, is self-moving. It stores 300 feet of augers in racks on the machine. The operator's view of the highwall is unobstructed.

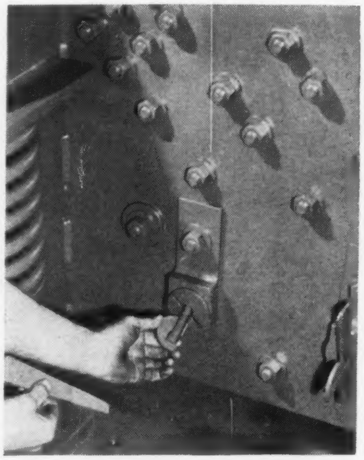
The Salem Dual is an entirely new concept in coal recovery drills. Investigate it today. Write for Salem Bulletin CR-D61. It gives complete information.



THE SALEM TOOL COMPANY

763 SOUTH ELLSWORTH AVE. • SALEM, OHIO

an integral part of the wire feed unit provides 125 lb of continuous welding wire. The Model C "Wear-O-Matic" unit is said to be ideal for applications in hard-to-get-at places where a hoist is used to position the feed unit. Also, it eliminates "short coil" loss. Alloy Rods Co., P. O. Box 1828, York, Pa.



SCREEN DECK CHANGING—A device making possible screen deck changes in only a fraction of the time formerly required and permitting tensioning of cloth while screen is operating, has been developed by Allis-Chalmers Mfg. Co., 986 S. 70th St., Milwaukee 1, Wis.

A 1¼-in adjustment on each side of the deck is provided by the new fastener. One size fits all sizes and types of vibrating screens.

HOSE CLAMP—Federal Laboratories, Inc., Saltsburg, Pa., is producing a worm drive hose clamp, called "Hi-Torque," from Allegheny Ludlum Steel Corp.'s Types 301 and 410 stainless steels. Obtainable in standard diameters from 2 to 6 in, this clamp uses V-band couplings to hold joints of hose and pipe together even under extreme pressure, vibration and corrosive conditions. Once adjusted they will not snap or jog loose.

DISTRIBUTOR DAN, the SKF bearing man, offers

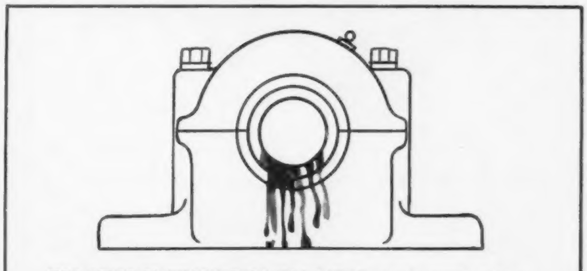
FIVE TIPS ON BEARING LUBRICATION

—that can save time and trouble for you

WHEN TO RE-LUBRICATE? Always follow the manufacturer's directions, if they're available. Most bearings, whether oil- or grease-lubricated, need cleaning and re-lubrication once a year. Re-lubricate oftener if the bearing is large, operates at high speeds or temperatures of 120-140 F. or higher.

WHAT GREASE CAN TELL YOU. Grease itself can tell you when cleaning and re-lubrication are needed. Dark grease means that oxidation has started or that abraded particles are present. Changes in the original color indicate water. Grease of a hard consistency should always be replaced.

WHEN TO CHANGE OIL. Compare the oil in the bearing with unused oil. Clouded oil indicates water. Dark oil frequently indicates sediment. Dark, pitch-like coatings on the rings, roller ends or cage mean the oil has become dirty or begun to carbonize. So, clean the bearing and housing and re-lubricate.



TOO MUCH IS WORSE THAN TOO LITTLE. Don't overlubricate. Only grease that actually contacts the bearing lubricates. Using too much grease may cause churning and lead to overheating and loss of lubricant. Remember: the higher the speed, the more sensitive a bearing becomes to excessive lubrication.

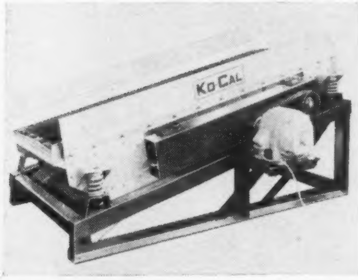
CLEANLINESS, FIRST AND LAST. Clean new oils and greases will usually force-out old lubricants in the bearings. But they won't if the lubricant is badly oxidized. Pour a hot aqueous emulsion into the housing. Rotate shaft until bearing is clean. Drain solution while rotating shaft. Then, flush with hot light oil, drain and add new lubricant.

Baffled by a bearing problem? Whether it's selection, mounting, or maintenance—consult your Authorized SKF Distributor. He's staffed to help you keep them running smoothly and he stocks all the bearing types and sizes you need.

SKF MOTION ENGINEERING

Advanced ball and roller bearing technology

TROUGHING IDLERS—Easy lubrication, simple installation and rugged construction are features of the "Style L" troughing idler offered for rope stringer conveyor systems. One grease fitting at the idler frame lubricates six bearings. Positive wire-rope attachments prevents idler movement and subsequent belt detraining. And the fastener design eliminates damage to wire rope. Individual idler rolls can be removed by loosening four bolts. An operating feature is the exposed center roll which eliminates return belt damage under severe service conditions. Hewitt-Robins, Dept. L, Stamford, Conn.

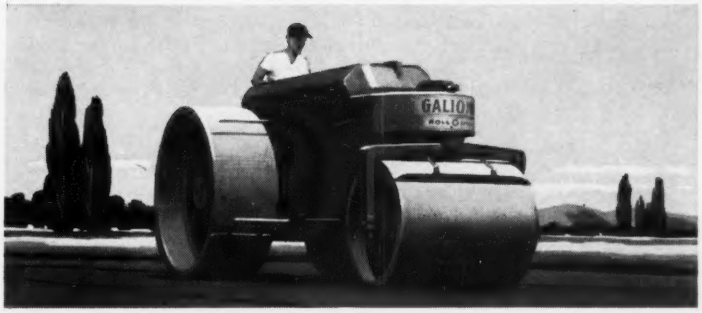


VIBRATING SCREEN — The Ko-Cal "Twin-Shaft" vibrating screen incorporates two shafts to provide screen pulsations. The uniform pulsating action over the entire length of the screen eliminates "gallop" and provides higher capacity. The "Twin-Shaft" takes its name from its double-eccentric shaft construction. Single-shaft construction normally is used. Other features include screen cloth bolted to side plates and oversize positive drive belt. A weight saving of 25% is realized over the single-shaft design. Koehring Co. of California, Stockton 4, Calif.

ENGINE OPTIONS—Two new horsepower-increasing engine options for the "Michigan" Model 380 (Series II) tractor dozer are offered by Construction Machinery Div., Clark Equipment Co., Pipestone Plant, Benton Harbor, Mich. One is the General Motors Model 12V-71, a 430-hp diesel. It is a 12-cyl, two-cycle diesel with 851.2-cu in displacement and produces a maximum of 1,210 ft lb of torque at 1,200 rpm. The other is the Cummins Model NVH, a 12-cyl diesel rated at 450 hp. This is a four-cycle engine with 1,486-cu in displacement and produces 1,232 ft lb of torque at 1,500 rpm. Both units have a 24-V electric system.

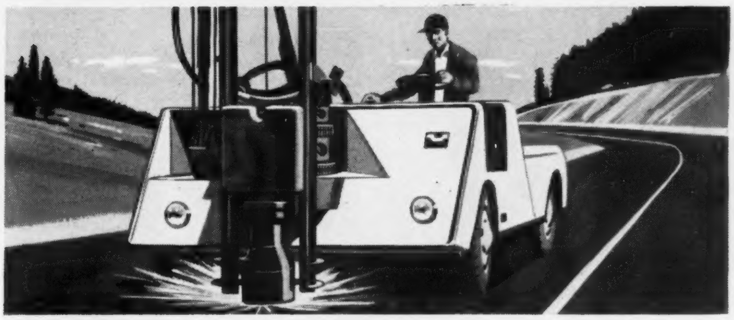
CENTRIFUGAL PUMPS—Two new self-priming centrifugal pumps offer fast 16-sec priming and outstanding performance characteristics, according to Barnes Mfg. Co., Mansfield, Ohio. New hydraulic principle and 40% larger pump

ALLISON
stops shift shock
TORQMATICALLY



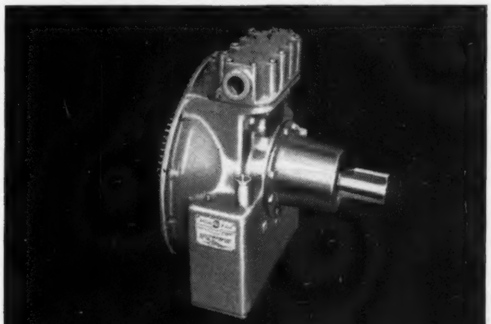
IN ROAD ROLLERS

Big reason rolling's so smooth with Galion Roll-O-Matic Drive is its 200-300 Series TORQMATIC Converter. Teamed with a 2-speed transmission, the converter eliminates sudden surges of power, makes it impossible to slip or dwell on the pass.



IN "10-IN-1" MACHINES

Fitted with various "Uni-Tools," the Ottawa Commando can be a truck, crane aerial tower, fork lift, bulldozer, snow plow, power broom, pavement breaker. Allison 200-300 Series TORQMATIC Converters help the Commando do all these jobs smoother, faster, easier.



IN ANY 40-50 H.P. UNIT

With six basic models and 25 different options available, the 200-300 Series TORQMATIC Converters can be used in tractors, ditchers, drilling rigs, cranes, shovels, and other 40-150 h.p. equipment.

Torque multiplication at stall ranges from 2.0 to 3.50, maximum torque input from 200 ft.-lbs. to 350 ft.-lbs., top input speed is 3,000 rpm. Available options include front disconnect clutch and adapter, rear disconnect clutch adapter, chain drive, automotive flange, industrial shaft. Write for the TC 200-300 brochure today.

Allison TORQMATIC

TORQMATIC® DRIVES

The world's most complete line of hydraulic drives

Over 980 models used by 108 manufacturers in 100 to 525 h.p. equipment

Allison Division of General Motors
Dept. CA-5, Indianapolis 6, Indiana

Please send me application data on your 200-300 Series TORQMATIC CONVERTERS.

Name ______________________

Title ______________________

Company ______________________

Address ______________________

City ______________ Zone ______ State ______________

body increase capacities and pressure to more than double former models. Designated the 5 and 7 series, these pumps are available with 1½- and 2-in suction outlets in gasoline-engine, electrical and universal-drive models.

MATERIAL - HANDLING BLADE—Coal handling is one of many new jobs that can be accomplished efficiently by Cats 966 Traxcavator when equipped with a Balderson BD966U-12-ft light material-handling blade, reports Balderson Inc., Wamego, Kan. The Balderson blade fits on the Traxcavator in place of the bucket, using the Traxcavator pins. The whole unit looks and performs like an earthmoving machine, according to Balderson.

SPEED REDUCERS—Fan-cooled helical worm-gear speed reducers are offered in ratios extending approximately from 34:1 to 394:1 and come in seven sizes, ranging from 4-in to 12-in center distances. Ratings are fractional to 58.5 hp. Details from Cleveland Worm Gear Div., Eaton Mfg. Co., 330 E. 80th St., Cleveland 4, Ohio.

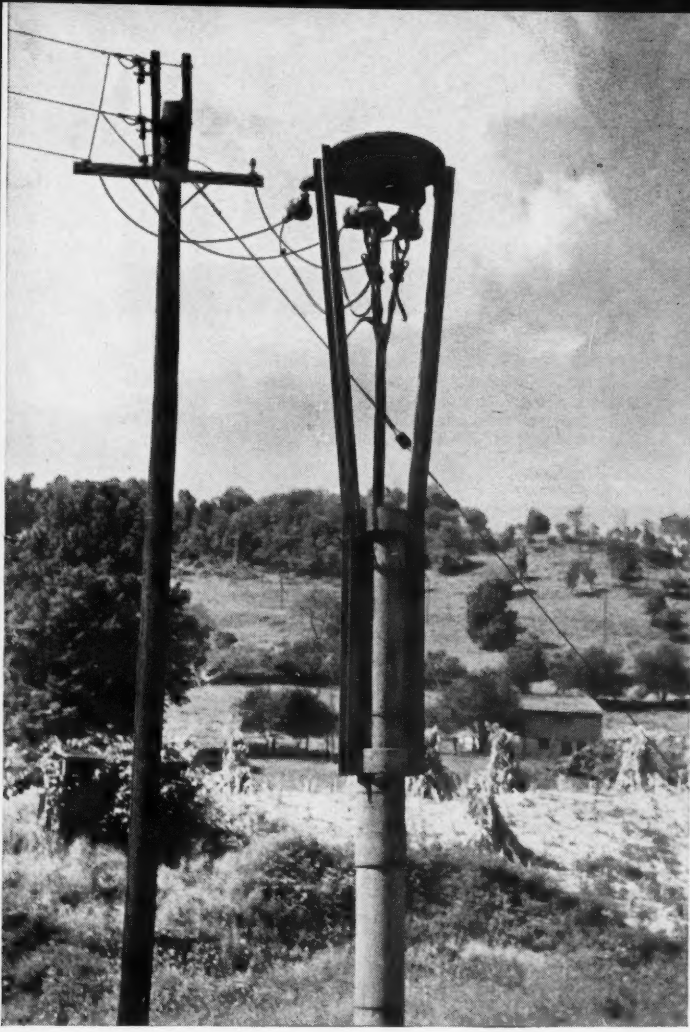
SCALE WEIGHT CONTROL—Cardinal Scale Mfg. Co., Webb City, Mo., has introduced the Microset 606 weight cut-off control for all dial-type scales. This unit supplies an electrical impulse to operate a feeder which in turn starts a flow of material into a weigh hopper. When the pre-set weight is attained, the electrical impulse is broken, de-energizing the circuit which stops the feeder operation. It is especially applicable to proportioning, batching and bagging operations. It can be equipped with single-stage or two-stage cut-off and is easily operated by one man.

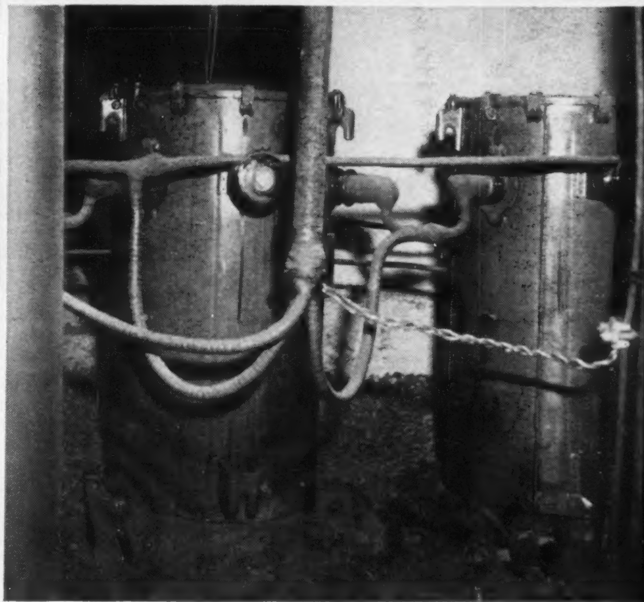
Equipment Shorts

Conveyor Belting—U. S. Rubber Co., 1230 Ave. of the Americas, New York 20, N. Y., has developed conveyor belting said to provide seven times more resistance to ozone than standard rubber conveyors and 60% more resistance to age hardening. "WeatherGard" covers of the new belting are, as the name implies, weatherproof and sunproof.

End Bits—Recommended for heavy-duty application, these self-sharpening end bits made of forged steel are available for No. 7A and No. 7S bulldozers. Because the leading edge and extended tip are shaped to sharpen as wear occurs, the optimum penetrating angle is retained throughout the life of the end bit. Caterpillar Tractor Co., Peoria, Ill.

Brattice Cloth—With safety in mind,

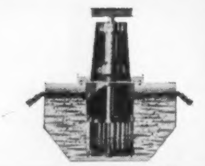




WEMCO EQUIPMENT

FOR COAL PREPARATION

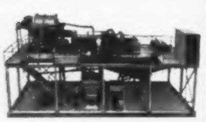
FROTH FLOTATION



WEMCOAL FLOTATION MACHINE

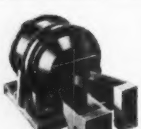
WEMCOAL Flotation cells and allied equipment are the solution to washery water reclamation and stream pollution problems, and have been chosen for over 90% of recent froth flotation installations. Low ash product with high recovery and low reagent cost are principal reasons for their wide acceptance in the industry.

HEAVY MEDIA SEPARATION



WEMCO MOBIL-MILL

A complete, pre-engineered, pre-fabricated HMS plant for profitable, premium coal production from first day of operation. Integrated design for rapid erection — and one man operation — even by inexperienced personnel. Answers ash reduction problems economically, profitably.



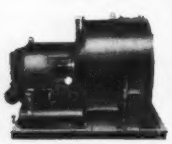
WEMCO DRUM SEPARATOR

Incorporated in Wemco Mobil-Mill for coal cleaning. Float material overflows; sink material is raised by lifters. Two compartment drums produce a true sink, true float and middling. Double drums make two separations.

WEMCO CONE SEPARATOR

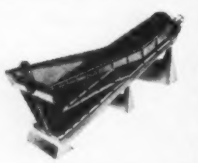
For sharp separations where longer retention time is required in size range of 4 inch to approximately 10 mesh. Clean coal floats to the surface and overflows; sink material removed by airlift.

DEWATERING AND PUMPING



WEMCO SIEBTECHNIK CENTRIFUGAL DRYER

A horizontally mounted vibratory screening centrifuge, proven superior for the drying of washed coal fines. Efficient dewatering is accomplished as solids are passed through a truncated screen whirled at high speed. Axial vibration keeps mass of particles loose, aiding dewatering and movement to discharge. Speed of basket, as well as amplitude and frequency of vibratory motion can be easily adjusted to meet requirements.



WEMCO COAL SPIRAL

High capacity, low cost dewatering device for coal from ⅜ inch to 48 mesh. Also serves as classifier for slimes and fines, making sharp overflow separation at 35, 100 or other desired mesh size. An important use is for dewatering of wet screen underflows.

WEMCO TORQUE-FLOW PUMP

Proven Torque-Flow pumping principle incorporates recessed impeller, continuous open passage. Permits pumping of large solids in slurry without clogging or degradation, and with minimum wear. Torque-Flow Pumps are ideal for pumping feed to cyclones.

WEMCO® *a division of*

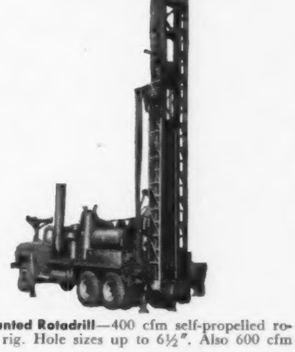
Western Machinery Company

650 Fifth Street, San Francisco 7, California

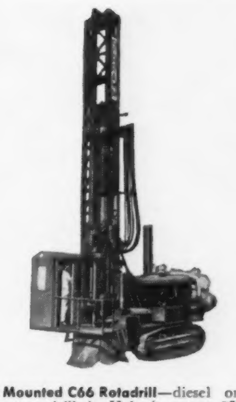
other offices in:

New York · Toronto · Hibbing · Paris

Pneumatractor Mounted Rotadrill—125 cfm rotary drill rig. Hole sizes—up to 4½". Also 250 cfm model with hole sizes to 6".



Truck Mounted Rotadrill—400 cfm self-propelled rotary drill rig. Hole sizes up to 6½". Also 600 cfm model.



Crawler Mounted C66 Rotadrill—diesel or electric, 600 cfm rotary drill rig. Hole sizes up to 8".

Here's a new standard of operating efficiency!

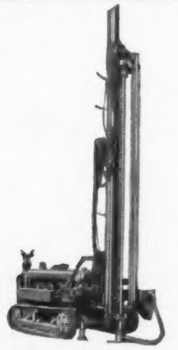
SCHRAMM CO-ORDINATED AIR POWER!

. . . lowers initial costs, manpower costs, maintenance costs!

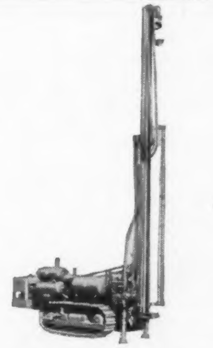
Looking for a new way to lower operating costs? Then consider all of your air-powered equipment as a total operating area—rather than as isolated pieces—to find the wastes and inefficiencies that can be eliminated.

Then look at a Schramm Co-ordinated Air-Power Package, in which each unit complements the other. For example: mass production of corresponding parts used throughout the line means lower initial and replacement costs; also high interchangeability of wearing parts between engines and compressors, between products, between sizes. Savings multiply with each unit you add. But this is just part of the story. There are also big savings in manpower, time, other operating costs! For full information, return the coupon below!

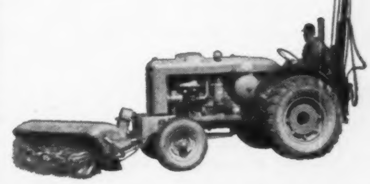
Rotatool—fast-penetrating percussion tool increases drilling rates by producing maximum fracturing action at the bottom of the hole.



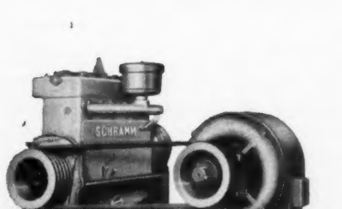
Crawler Mounted C42 Rotadrill—250 cfm rotary drill rig, holes to 6" with 22' mast travel.



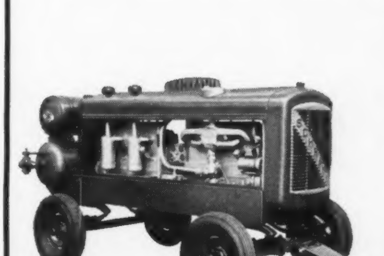
Truck-Mounted or Crawler-Mounted Do-it-yourself Kit—Complete Rotadrill package mounts on your own truck or tractor. Saves vehicle cost. Hole sizes to 6".



Self-propelled Compressors—Models 125 & 250 Pneumatractors—one man drives and operates. Wide range of accessories.



Stationary Compressors—electric motor or V-belt drive. Vibrationless operation—no foundation needed. 50 to 600 cfm.



Portable Compressors—Models from 20 cfm to 600 cfm. Economical, dependable, deliver full rated capacity at 100 psi.

Please send full data on:
Schramm Co-ordinated Air-Power Package, and . . .

- ☐ Truck Mounted Rotadrills
- ☐ Crawler Rotadrills
- ☐ Pneumatractor Rotadrills
- ☐ Do-it-yourself Rotadrills
- ☐ Rotatools
- ☐ Standard Pneumatractors
- ☐ Heavy Pneumatractors
- ☐ Portable Compressors
- ☐ Stationary Compressors
- ☐ Schramm Air Tools

Name ____________________

Title ____________________

Company ____________________

Address ____________________

City ______________ Zone ______ State ______

SCHRAMM
CO-ORDINATED AIR POWER
675 GARFIELD AVENUE • WEST CHESTER, PENNA.

B.E.P. Industrial Equipment has designed its Translucent Brattice Cloth. Its function is to provide airproof curtaining through haulage drifts and its translucent properties permit miners to see light of approaching shuttle cars. In addition it is weatherproof and fireproof. 6346 W. McNichols Rd., Detroit 21, Mich.

Rebuilders — The "Multi-Matic Rebuilder" has been designed to meet the need for a multiple spindle machine capable of handling the rebuilding of all types of mining and other equipment on a high-speed, economical basis. Automatic Welding Co., Box 57, Waukesha, Wis., also offers its Dual Head Micro-Matic Roller & Idler Rebuilder. This unit is a high-production, completely automatic resurfacing machine.

Belted Drive Advance—By using oil-lubricated antifriction bearings and new narrow-width belts, it is now possible to V-belt higher horsepower (to 350) and higher speed motors (1,200 rpm) without using an outboard or third bearing. Details of this announcement from Allis-Chalmers Mfg. Co., 986 S. 70th St., Milwaukee 1, Wis.

Speed Reducer — A fractional-horsepower speed reducer, smallest in the Torque-Arm line, is offered by Dodge Mfg. Corp., Mishawaka, Ind. The TDO-25 has a gear ratio of 25 to 1 and will transmit up to .95 hp at maximum recommended output speed of 85 rpm.

Dewatering Pump—The 8-in Submersible Dewatering Pump released by Gorman-Rupp Co., has a capacity range from 1,000 gpm at 148-ft head to 2,070 gpm at 40-ft head. For further details of the Model S8A1, write the company at 305 Bowman St., Mansfield, Ohio.

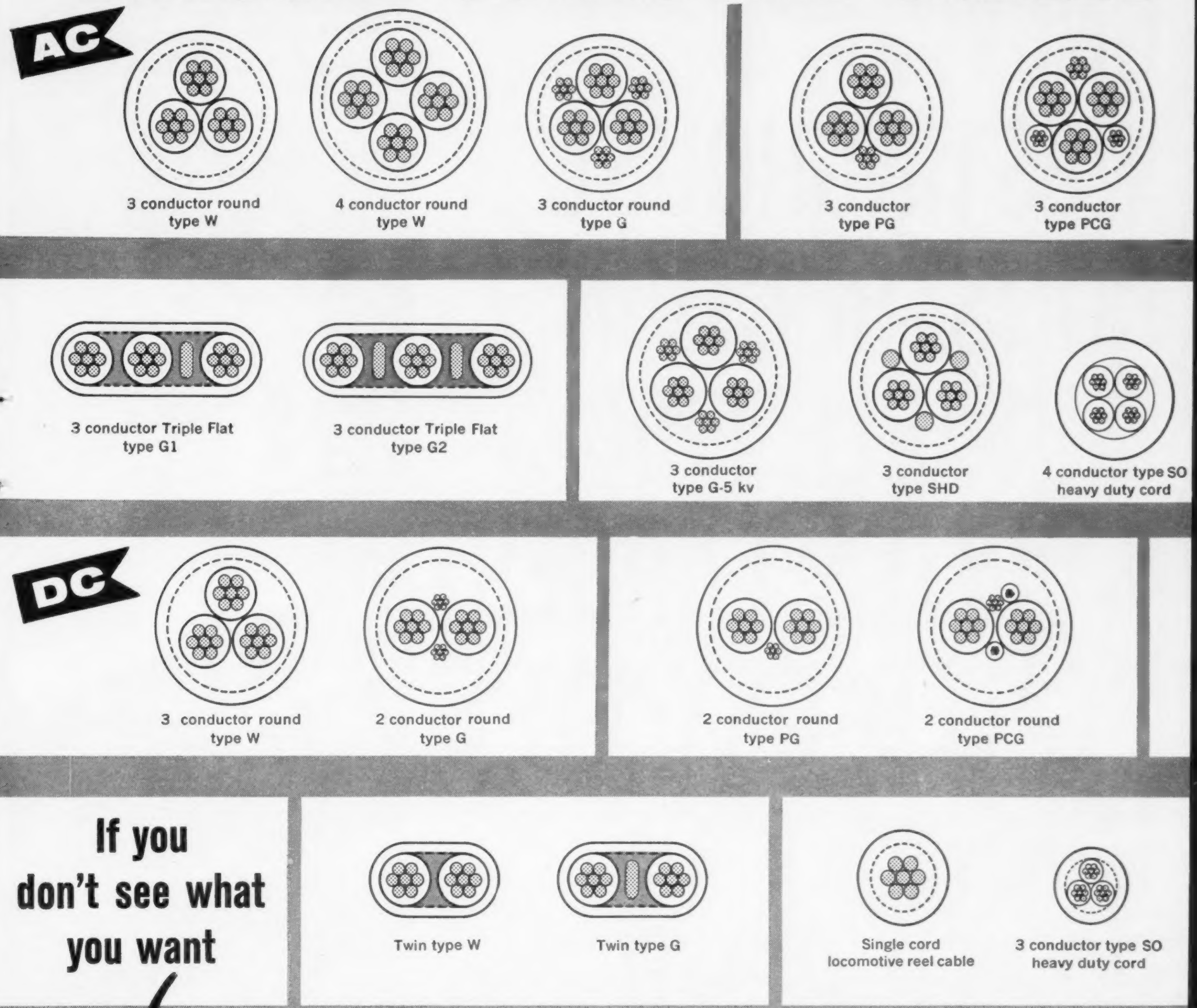
Welding and Cutting—Harris Calorific Co., 5501 Cass Ave., Cleveland 2, Ohio, offers a heavy-duty welding and cutting outfit. A heavy-duty welding torch which takes up to a size 22 tip and high-temperature silicone "O" ring seals are featured.

Free Bulletins

Dust Collector—A simple, highly-effective collector which draws dust through hollow drill steel during placement of holes for roof bolts in underground mechanical operations is described in Bulletin 1207-2. For your copy of this brochure covering the M-S-A Thru-Steel Dust Collector, write Mine Safety Appliances Co., 201 N. Braddock Ave., Pittsburgh 8, Pa.

Trailers—Ravens-Metal Products Inc., 1300 Market St., Parkersburg, W. Va.,

OKOCORD CORDS AND CABLES



If you don't see what you want

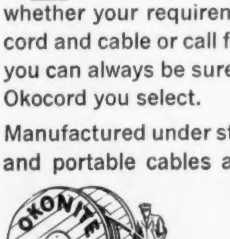
ASK FOR IT

Okonite's Cable'bility* in producing quality cords and cables is reflected in the eighteen standard constructions shown above. But these eighteen cords and cables are by no means the end to Okonite ingenuity. Designing special constructions to meet the specific demands of <u>any</u> operation is another Okonite feature. However, whether your requirements can be met by a standard cord and cable or call for "custom-designed" attention, you can always be sure of consistent high quality in the Okocord you select.

Manufactured under strict quality control, flexible cords and portable cables are protected by a rugged reinforced Okoprene jacket with the extra durability and flexibility that comes from curing in a continuous metal mold. Tough nylon open braiding . . . resilient, heat-resisting insulation . . . extra fine gauge wires twisted together with a short lay—are Okocord quality features that assure long service life.

From the inside to the out, Okocord remains the standard of quality for strip mining and underground applications. For complete details on Okocord cords and cables write for Bulletin CA-1180, The Okonite Company, Subsidiary of Kennecott Copper Corporation, Passaic, N. J.

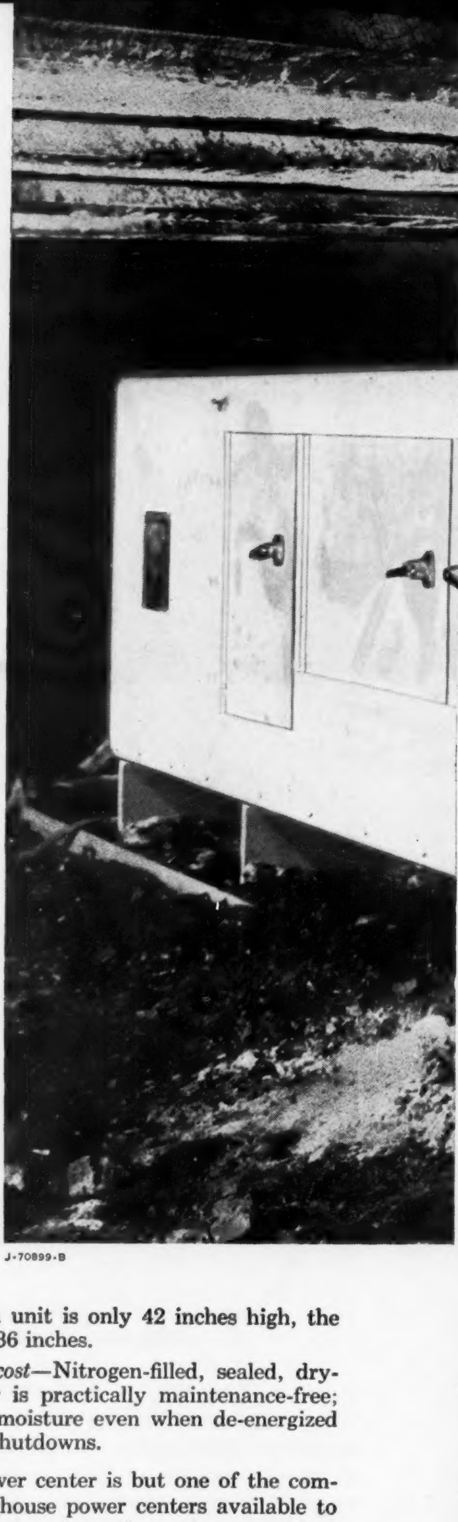
*OKONITE Cable'bility . . . cable craftsmanship since 1878.



where there's electrical power . . . there's **OKONITE CABLE**

6378

ONLY WESTINGHOUSE CONSTRUCTION SUITABLE FOR WORLD'S LARGEST SEALED DRY-TYPE MINE POWER CENTER



J-70899-B

MINE power center specifications are extremely exacting . . . so exacting that only Westinghouse, the leader in the field, offered a construction found suitable for the world's largest sealed, portable mine power center.

Only Westinghouse construction could combine—in a unit with the desired 600-kva, 7200/480-volt rating—the necessary ruggedness, compact low height and light weight essential to easy portability within mine tunnels.

Here are the key features in this construction:

External ruggedness—A ¼-in. steel plate case protects against roof falls, rough use. A ⅜-in. base plate with ½-in. reinforcing skid runners protects the unit when skidded over rough bottom, haulage tracks, etc., during frequent relocation.

Internal ruggedness—Core and coils braced at both top and bottom to withstand full short circuit conditions, securely mounted in case to withstand moving and rough handling.

Low height—The most compact mine power centers made, the 600-kva unit is only 42 inches high, the 300-kva unit only 36 inches.

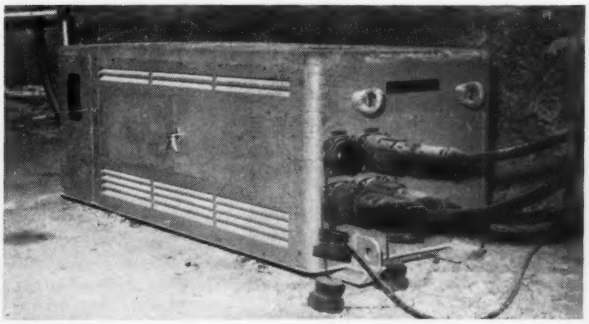
Low maintenance cost—Nitrogen-filled, sealed, dry-type power center is practically maintenance-free; protected against moisture even when de-energized during prolonged shutdowns.

This sealed mine power center is but one of the complete line of Westinghouse power centers available to serve the mining industry above the surface, as well as below. Ask your Westinghouse representative about the power center to serve your specific applications.

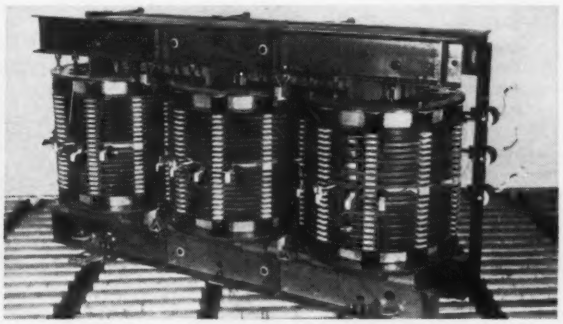
You can be sure . . . if it's
Westinghouse

Convenient location of the high-voltage receptacle on world's largest sealed mine power center permits hitching to low-voltage end when unit is skidded to a new location. This allows unit to remain energized; high-voltage cable can pull straight without bending, and buggy can obtain its motive power from one of the secondary feeders.

A full range of ratings in ventilated mine power centers is available from Westinghouse for application where conditions are less severe—such as less dust, lower humidity.



Core and coil assembly for 600-kva, 7200/480-volt, 3-phase unit—world's largest sealed mine power center made by Westinghouse.



offers literature on its all-aluminum trailers and truck bodies. Sheets are illustrated and include specifications.

Continuous Miner—A 4-p folder sets forth appointments of the "Mark 20," a 20-in overall low continuous miner. Write Wilcox Mfg. Co., P. O. Box 217, Raleigh, W. Va.

Welding—"The Welding of Mild and Alloy Steel" is an informative 20-p catalog offered by McKay Co., 1005 Liberty Ave., Pittsburgh 22, Pa.

Bits—Latest improved coal bit designs are featured in Catalog VR-489. A bit selection guide in the form of special charts and drawings is included. Vascoloy-Ramet Corp., Waukegan, Ill.

Borer and Shuttle Car—Two new sheets covering the Goodman 428 continuous borer and 1070 shuttle car have been added to Goodman Mfg. Co.'s supply of literature. Halsted St. and 48th Pl., Chicago 9, Ill.

Drilling Equipment—Catalog 615 has been released by Mobile Drilling, Inc., covering the company's complete line of hydraulic-powered drill rigs, tools and accessories. Fully illustrated, this 80-p catalog includes detailed descriptions and specifications on over 1,900 items.

Coal Preparation—Descriptions of the company's coal preparation equipment and engineering data and reference tables are included in Coal Preparation Manual 561 issued by McNally Pittsburg Mfg. Corp., Pittsburg, Kan.

Motors and Drives—For your copy of Bulletin 116 covering motors and adjustable speed drives for the coal industry, write Louis Allis Co., 427 E. Stewart, Milwaukee, Wis.

Belt Weigher—The need of continuous process industries for measurement and control of flow of dry materials at low to medium rates is met by Model 36-02 Belt (Stream) Weigher manufactured by B-I-F Industries, P. O. Box 276, Providence 1, R. I. Bulletin Ref. No. 36-02.20-1 gives full details.

Pneumatic Tools—Through the Marquette Div. of Curtiss-Wright Corp., the complete line of pneumatic hand tools built by the Grasso Works, of Holland, are now available throughout the U. S. For full information on the line, ask for Form 643031-0102 from Curtiss-Wright, 1145 Galewood Dr., Cleveland, Ohio.

Switchgear—Advanced design features of 600-V switchgear with K-Line circuit breakers are described in Bulletin 3200-1A offered by I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

? will these suggestions help you get more production from your wire screens ?

Screening efficiency and wear life are increased when Oblong Space and Longslot specifications are designed and woven with the long opening parallel to the screen width.

In Double Crimp construction, as standard practice, we weave and edge the cloth sections so that the deeply crimped fill wires parallel the material flow.

On screens of .080 wire diameter and smaller, it is our standard practice to spot weld the edge through the cloth on 6″ centers to prevent "pull-out", flexing and subsequent fatigue failure.

The larger diameter wires in HOYT Screens are single-crimped, rather than wheel or gang crimped. On wire diameters .312 and larger, it is possible to space or skip crimps to allow for a flat bearing surface across a center hold-down bar, or a flat feathered edge to rest on the side shelf.

For more effective open area and greater efficiency in Smoothtop Longslot specifications, we can space "clusters" so that they fall over the solid bucker-up bars. Open area gain is often 3 to 5 percent. Smoothtop construction on Longslot specifications is another HOYT "exclusive".

We're interested in helping you overcome production difficulties at your screening stations. No matter what the problem may be . . . blinding, plugging, corrosion, open area, poor wear . . . our salesmen are trained to recognize and eliminate trouble spots. They can call upon a background of many years of experience and actual case histories to aid you. Call or write us. Your request will receive immediate attention.

HOYT HANDBOOK FREE

A ready source of tables, practical recommendations, ordering and other useful information. Your copy free upon request.

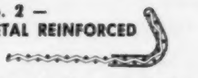
BUILDING CONFIDENCE THRU INTEGRITY, QUALITY AND SERVICE •

HOYT WIRE CLOTH COMPANY

P. O. BOX 1577, LANCASTER, PA. - PHONE EXpress 4-6871

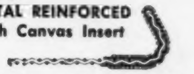
EDGE TYPES

No. 2 — METAL REINFORCED



For wire diameters .063″ to and including .250″, depending on type of crimp and grade of wire.

No. 3 — METAL REINFORCED With Canvas Insert



Recommended for wires sizes .047″ to .072″, to help lessen fatigue failure.

No. 4 — SQUARE EDGE BAR

For wire diameters over .3125″ and especially for wire diameters of .4375″ and larger where No. 6 Edge is too high.

No. 5 — ROUND MILD STEEL EDGE WIRE, WELDED

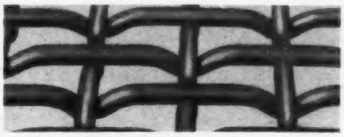
For use on vibrators that use hook bolt tensioning.

No. 6 — WELDED MILD STEEL ANGLE

For use on wire diameters .250″ and larger where a turned edge is specified. (See No. 4).

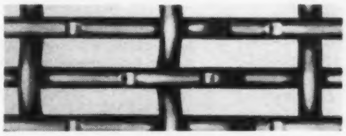
No. 7 — WELDED PLATE INSERT

Recommended for wire diameters .3125″ and .375″.



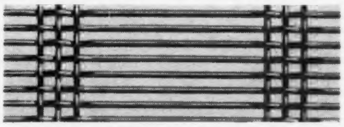
SMOOTHTOP

All crimp projections (knuckles) are on underside, presenting over 50% more metal to flat wearing surface. Assures uniform, even wear.



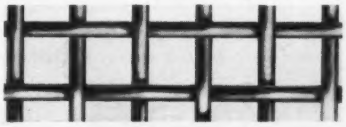
OBLONG SPACE

Offers greater open area than square openings with only slight sacrifice in sizing efficiency. Free-flowing design.



LONG SLOT

Provides maximum open area. Ideal for screening materials that are nearly cubical or round in shape, and which tend to blind or plug square openings.



DOUBLE CRIMP

Recommended for all square openings smaller than ⅝″, or where wire diameter is too large in relation to opening to permit use of Smoothtop construction.

Among the Manufacturers

Nortons-Tividale Ltd. is opening a Chicago office at 307 N. Michigan Ave. E. Clinton Griggs will be U. S. manager of sales for dense-medium washers, jigs.

Lister-Blackstone, Inc., Long Island City, N. Y., has named new distributors for Lister diesel engines. Included are Acme Power Supply Co., Inc., 3014 W. 43rd St., Kansas City, Kan., to cover eastern Missouri; and Brinker Supply Co., 6545 Hamilton Ave., Pittsburgh, Pa., to cover southwestern Pennsylvania.

W. S. Tyler Co., Cleveland, Ohio, has announced several personnel appointment. Changes in the Screening Machinery Div. include **James W. Sullivan,** named chief application engineer; **Edwin E. Cockrell,** director, Customer Service Laboratory; and **Sherman Telling,** manager, Machinery Service Dept. In addition, **James B. Carpenter** has been made manager, international sales, of both W. S. Tyler Co. and W. S. Tyler International Co., and **Russell Robinson,** assistant export manager.

A. Blake Caldwell Jr. has been appointed manager, mining sales and development, Gum & Technical Products Dept., Morningstar-Paisley, Inc., New York, N. Y. He will handle sales development of flocculants and other products for the mining industry. Previously Mr. Caldwell has been associated with American Cyanamid Co. and U. S. Gypsum Co.

Phillip H. Booth has succeeded Lewis V. Kuhnle, now retired, as manager of carbon bar, rod and wire sales, Youngstown Sheet & Tube Co. Mr. Booth was manager of alloy sales and will continue to handle sales of alloy bars in his new post. He joined the firm in 1929 as an inspector, advancing to alloy metallurgist and then manager of bar sales.

Recently-appointed district representative of Koehring Div., Koehring Co., is Charles E. Petot. With headquarters in Cleveland, he will cover Kentucky, Ohio, Indiana and Michigan.

Lewis J. Burger has been named president, LeTourneau-Westinghouse Co., succeeding Merle R. Yontz, who resigned to accept a position with Caterpillar Tractor Co. Mr. Burger was formerly associated with General Electric in various management capacities.

Company Briefs

McNally Pittsburg Mfg. Corp. recently acquired the controlling interest in Kennedy Van Saun Mfg. & Engrg. Corp., although the latter firm will continue to operate as an independent corporation. **Maurice Shafer** will become president of the firm upon retirement of **Byron H. Pyle,** and **Edward T. McNally,** McNally president, will become chairman of the board. Other officers as well as operating personnel will continue in their present posts. And sales, engineering and manufacturing will continue as before.

An agreement of mutual support in the engineering and marketing of automated control systems and processes has been announced by Allis-Chalmers, Consolidated Systems Corp. and International Business Machines Corp. The three companies would work together when it is in the customer's best interest to have a coordinated system, officials of the firms said. Efforts of this kind would be directed toward "a total industrial control system." A typical integrated system would utilize Allis-Chalmers' basic industrial equipment, Consolidated Systems' special instrumentation and IBM's data processing equipment.

FALK

...a good name in industry

QUALITY GEAR DRIVES and FLEXIBLE SHAFT COUPLINGS

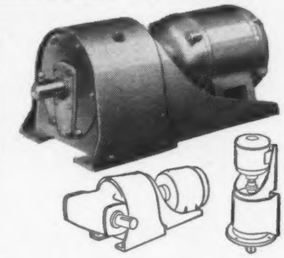
THE FALK CORPORATION, MILWAUKEE 1, WIS. *Representatives and Distributors in many principal cities.*

● The helical and spiral bevel gears in Falk gear drives assure maximum mechanical efficiency attainable—98½% per gear mesh under full load.

ALL-MOTOR MOTOREDUCERS *up to 125 hp.*

All-steel units for use with any NEMA foot-mounted motors within rated capacities of the gear drives. Standard output speeds from 1 to 780 rpm (with 1750 rpm motors); as low as .032 rpm in semi-standard designs. Also Integral units, from 1 to 40 hp.

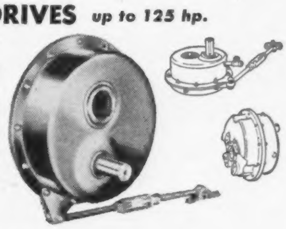
Ask for Bulletin 3100.



SHAFT MOUNTED DRIVES *up to 125 hp.*

All-steel units, horizontal or vertical. Output speeds between 420 and 5 rpm. Maximum torque rating at low speed shaft: 100,000 lb-in. Consult Factory for higher capacities and for flange mounted drives.

Ask for Bulletin 7100.



SCREW CONVEYOR DRIVES *up to 40 hp.*

Bolt to any standard trough end. Output speeds from 420 to 5 rpm. Max. torque rating at low speed shaft: 44,000 lb-in. Drive includes removable drive shaft and seal housing with choice of seals. Trough end and Motor Mount optional.

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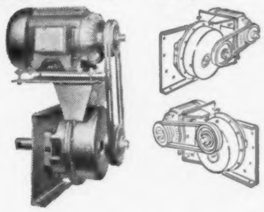
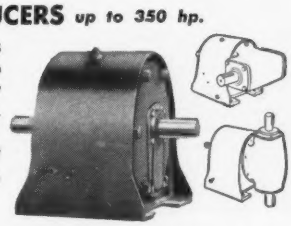


SMALL SPEED REDUCERS *up to 350 hp.*

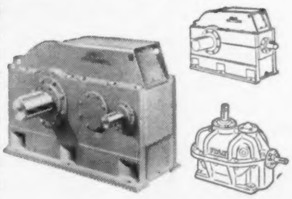
Concentric Shaft reducers with ratios from 1.49:1 to 970:1. Maximum torque at low speed shaft: 94,000 lb-in. **Right Angle** ratios from 5:1 to 1460:1. Maximum torque at low speed shaft: 73,000 lb-in.

Ask for Bulletin 1105.



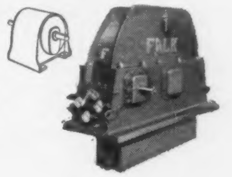
LARGE SPEED REDUCERS *up to 5800 hp.*

Parallel Shaft up to 5800 hp. Ratio range: from 2:1 to 292:1. Maximum catalog torque at low speed shaft: 1,570,000 lb-in. Bulletin 1100. **Right Angle Horizontal** up to 1900 hp. Ratio range from 5:1 to 1200:1. Max. catalog torque at low speed shaft: 1,570,000 lb-in. Bulletin 2100. **Right Angle Vertical** up to 760 hp. Ratio range from 6:1 to 430:1. Max. catalog torque at low speed shaft: 714,000 lb-in. Low speed shaft extension up or down. Bulletin 2110.



HIGH SPEED DRIVES *... reducers or increasers.*

Parallel Shaft drives cataloged up to 5,000 hp or 10,000 rpm. Unit ratios from 1.15:1 to 12:1. Bulletin 5105. **Concentric Shaft** units cataloged up to 225 hp or 4500 rpm. Ratios from 1.5:1 to 25:1. Bulletin 1106.



STEELFLEX COUPLINGS *protect connected machines.*

Hp range: ½ through 72,000 hp at 100 rpm. Exclusive grid-groove design cushions shock loads, accommodates reasonable degrees of shaft misalignment. Basic Type F for 9 out of 10 industrial applications, horizontal or vertical.

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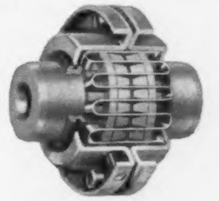
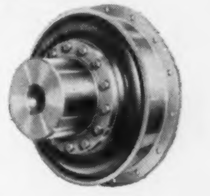


Basic Type F

AIRFLEX COUPLINGS *Designed for mounting shaft-to-shaft, shaft-to-flywheel, or shaft-to-flange.*

15 sizes covering a range from 5 through 2880 hp at 100 rpm. Ideal for applications which have irregular torque characteristics in driving or driven machines (internal combustion engines, reciprocating compressors, etc.).

Ask for Bulletin 8100.



SINGLE HELICAL and HERRINGBONE GEARS

Exclusive Falk extra-depth, high pressure angle gear teeth provide greater strength and protection against abrasion. AGMA ratings. Hub or ring gears in solid or split designs.

Diameters up to 23'-9" PD.

Face widths up to 6'.

Diametral Pitch: ¾ to 6 DP.

Ask for Engineering Reports 6170 and 6171

Ring Gears

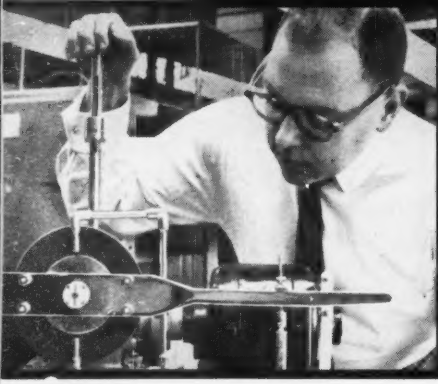
Hub Gears

Special GEAR DRIVES for any application.

Special HIGH SPEED DRIVES... over 50,000 rpm.

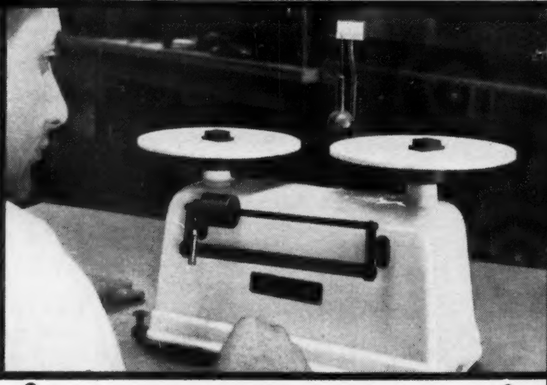
Marine PROPULSION DRIVES for turbine and diesel.

Make the test where



Circle laboratory technologist conducts an abrasion test on a sample of neoprene cable sheathing which must perform well within minimum tolerances.

Weighing of samples after comparative abrasion test shows how Circle cable sheathing has abraded considerably less than competitive brands.



it counts...

in the mine !

Comparative tests confirm the long life and outstanding performance of Circle mining machine cables.

Laboratory tests as well as in-the-field service records prove Circle mining machine cables outlast, outperform ordinary cables in resistance to abrasion and tear—last from weeks to months longer on the job.

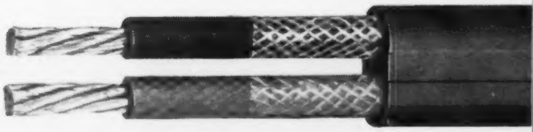
The reason for this is the specially compounded, unusually tough neoprene jacket that seems indifferent to the brutal beating all cable takes in a mine.

Special compounding techniques plus careful mold curing team up to give this Circle protective sheath its unusual toughness. The compounding involves a unique blend of various carbon blacks with other ingredients that enables Circle to obtain an optimum balance of properties in the cable jacket. Mold curing locks these properties in for maximum performance in the field.

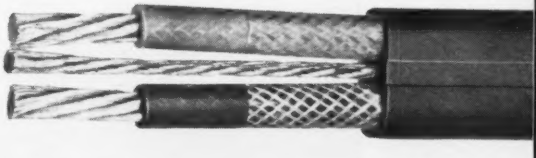
Why not test a Circle mining machine cable alongside the brand you're using now. See first hand how Circle cables give you longer life for your cable dollar. Next time you order cable, specify Circle.

CIRCLE WIRE & CABLE *a subsidiary of* CERRO CORPORATION

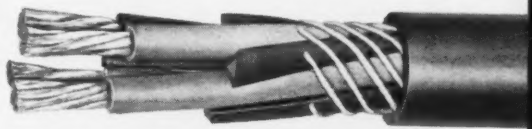
PLANTS: Maspeth and Hicksville, N. Y. **SALES OFFICES:** In all principal cities.



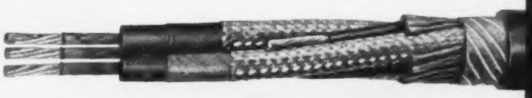
FLAT TWIN PORTABLE POWER CABLE, Type W 600 V—Normally used on track-mounted coal-cutters, loaders, etc. Flat shape resists crushing, allows easier coiling on take-up reels. Recommended maximum voltage: 1000 V.



FLAT TWIN PORTABLE POWER CABLE, Type G 600 V—Used for machines with pneumatic tires requiring vehicle frame to be maintained at ground potential. Any other application where grounding conductor is required. Recommended maximum voltage: 1000 V.



THREE AND FOUR CONDUCTOR MACHINE CABLE, Type W and Type G 600 V—Used for air conditioning apparatus, portable welding machines, dredges, and other types of portable equipment. In hazardous applications where grounding is required, Type G is preferred. Recommended maximum voltage: Type W—3000 V; Type G—5000 V.



SHOVEL CABLE, Type SH-D 2000 V to 15,000 V maximum—For electric shovels and other portable machinery with high voltage circuits. Shields on individual conductors provide protection to personnel, protect against corona. Ground wires are sufficiently large to assure positive grounding of equipment frame.

LOCOMOTIVE OR TRAILING CABLE, 600 V—Used primarily as trailing cable for mine locomotives operating beyond limits of trolley wire. May also be used as a motor lead cable.

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You don't have to mix these new economy blasting agents

DU PONT NILITE® 101 AND 202

The minute you tear the corner off your first 50-lb. bag of "Nilite" 101 or higher-density "Nilite" 202, you'll enter a new era in blasting.

Now at last you have two low-priced, free-running blasting agents that give you Du Pont quality performance, shot after shot.

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No clouds of dust, and no ingredient to cause headaches. No messy oil-stained bags.

But easy loading is only part of the story of "Nilite." For full data on rock-breaking power, better propagation, greater safety and other advantages, send for our new fact sheet on "Nilite" or call your Du Pont distributor or representative. Start saving on your blasting . . . soon. Du Pont, Explosives Department, 6440 Nemours Building, Wilmington 98, Del.

Flows freely even in holes as small as . . .

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. . . THROUGH CHEMISTRY

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The job has been completely preassembled on the layout floors of our Johnstown, Pa., plant in order to assure a perfect fit at the final site. We'll handle your special track jobs with equal care. Thorough study of your needs, careful fabrication of the various track components, and meticulous check on every detail . . . all add up to efficient track that will cut your operating costs. A Bethlehem engineer would like to discuss this with you, at your convenience.

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for Strength
... Economy
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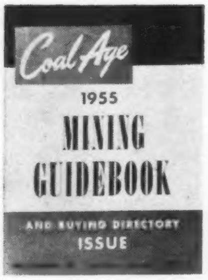
COAL AGE

JULY 1961

THE MINING GUIDEBOOK

Equipment . . . Materials . . . Services



1955

Tons per Man
Bituminous Anthracite
9.84 3.96

•

Continuous Mining Begins to Roll

•

First of the "Super" Shovels (60 Cu Yd) Completed

•

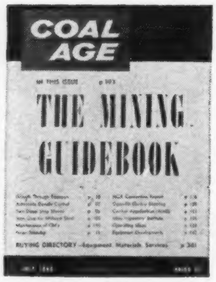
Ammonium-Nitrate Blasting Introduced in Stripping

•

Bituminous Dense-Medium Cleaning Total Reaches 50 Million

•

Ropeframe Conveyor and Solid-Carcass Belting Introduced



1960

Tons per Man
Bituminous Anthracite
13.0 6.0

•

Commercial Development of Remotely-Controlled Mining Starts

•

Manufacture of 155-Yd Shovel Starts; 85-Yd Dragline Ordered

•

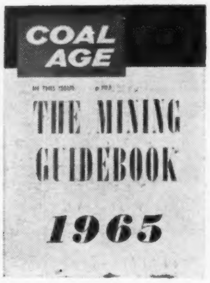
Mechanical Cleaning of Bituminous Moves up to 67% Plus

•

Drying Lead Taken by Suspension and Fluid-Bed Units

•

AC Power Becomes Significant Factor



1965

Tons per Man
Bituminous Anthracite
17.0 8.0

•

Production: Two Thirds Deep, One-Third Strip

•

Half Deep Output From Continuous Machines; Significant Percentage From Robot Units

•

Shovels and Drags Over 150 and 120 Cu Yd Planned or Building If Not Already in Use

•

"Laborless" Preparation the Rule, Not Exception

•

Machine Cost a Major Per-Ton Expense Item

	1955		1960		1965	
	Bituminous	Anthracite	Bituminous	Anthracite	Bituminous	Anthracite
Output, tons	464,633,000	26,205,000	415,000,000	18,500,000	525,000,000	15,000,000
Deep	343,465,000	14,499,000	287,000,000	8,000,000	345,000,000	7,000,000
Strip	115,093,000	7,704,000	120,000,000	6,500,000	170,000,000	6,000,000
Auger, other*	6,075,000	4,002,000	8,000,000	4,000,000	10,000,000	2,000,000
Average value	$4.49	$8.00	$4.75	$7.75	$5.00	$8.00
Number of mines	7,856	....	8,000	....	8,000	....
"Practical" capacity	575,000,000	....	500,000,000	....	600,000,000	....
Avg. men working	225,000	33,500	160,000	19,000	145,000	10,000
Days worked	210	197	180	162	210	180
% continuously mined	10.9	....	25.0	....	50.0	10
Total % deep mechanically produced	84.6	45.9	88.0	50.0	90.0	55
Tons per man deep	8.62	....	10.50	....	14.0	....
Tons per man strip	21,18	....	23.00	....	26.0	....
Tons per man auger	24.85	....	29.00	....	30.0	....
% mechanically cleaned	58.7	100.0	67.0	100.0	75.0	100.0
% of cleaned heat-dried	7.0	....	15.0	....	25.0	....

*In anthracite, dredging, culm banks, etc

Coal Progress...

Key Ingredients

The Record Since 1955

The Job Ahead to 1965

How rapid the pace of progress is in coal mining is difficult to appreciate unless one stops to take a close look. Without such study one might assume that things at the end of one 5-yr period might be only nominally different from things at the beginning. Not so in coal. Things move fast—much faster than one sometimes realizes.

The speed with which coal originates and adopts new equipment and methods is exemplified by developments in the relatively short span of years covered by the *Coal Age* Mining Guidebooks. The first was in Mid-September, 1955. Between then and 1960—one 5-yr period—tons per man rose one-third in bituminous and one-half in anthracite. To look ahead, both should rise another one-third or more by 1965—now less than 5 yr ahead by the calendar.

Some of the things involved in this past progress, and some that may be among the keys to future progress, are summarized in tables on the opposite page. One may debate whether production in 1965 will be more, less or exactly the 525 million forecast for bituminous and the 15 million for anthracite. And one can discuss other questions—for example: "Can bituminous strip tonnage attain the 170 million set down for 1965, which would be the figure if it should increase its present 30% share even modestly?" If stripping tonnage rose to 170 million it would be a reasonable conclusion that some additional capacity and manpower would be necessary.

But one thing is certain in coal mining above all. There can be no letup in the drive to hold down mine prices, enhance quality and attain the utmost in safety. Competition makes it impossible to do otherwise. Coal is fortunate, however, in having a big working margin. The labor content of the mine price is now 40 to 45% for the bituminous industry. The ultimate, in all probability, will be not over 20 to 25%.

Equipment, materials and methods are basic in the attainment of these labor-content figures, as well as the industry's quality and safety goals. Pioneering is a necessity, though pioneering must be based on thorough understanding and application of the basic principles on which progress must be based. Thus mining progress involves the necessary attention to the fundamentals, the most-efficient utilization of equipment, materials and methods currently available, and a constant search for new and better equipment, materials and methods.

It was to facilitate management thinking and action in all these respects that *Coal Age* originated its Mining Guidebooks which, with all the regular issues, are dedicated to progress in mining, preparation, safety and all related activities.

Efficiency Guideposts

Investment Policy . . . Cost Control
Supporting Services

Since 1955

Barely getting under way in that year, the industrial-engineering approach to efficiency and cost control is now widely employed, bringing with it, among other things, wider use of machines for providing the necessary budget and control data.

Ahead to 1965

Some 50 to 60 big new mines probably will have to be built or started in this 5 yr or so, plus major modernization work at many others.

A substantial rise will take place in the use of "Operations Research" principles, with computer calculation to arrive at the best possible methods of carrying out specific operations.

More training of both top management and supervisors will be the rule.

HOW EFFECTIVE management is, other things being equal, basically is the measure of the success of a business enterprise. The overall goal is a product that will sell easily, in good volume, and at a price that will yield a good profit. This presupposes careful study of coal and market or markets, and the establishment of an effective sales and consumer service organization. Efficient, safe production and quality preparation then become the other major ingredients. Guideposts to efficiency, quality and safety include the following:

Investment Policy

IT IS LITERALLY TRUE that spending money is the way to make money in coal mining—that is, of course, if the money is spent wisely. The goals are:

1. A reduction in mine cost.
2. A reduction in injuries and fatalities.
3. Enhancement of quality to the maximum consistent with added benefits to the consumer,

Basic policy in this area therefore should be one of constant checking on new machines, new methods and new materials with the idea of replacing the old as soon as the new will result in the necessary reduction of cost, promotion of safety and enhancement of quality, to more than return the cash outlay. Thus, for example, if a new miner, with a life of 5 to 6 yr, will return its cost, less the salvage price of the old unit or units, in 2 or 3, the decision is clear: Buy!

From the cost-reduction standpoint, there are perhaps three major reasons for buying new, higher-capacity, longer-life equipment and materials:

1. Direct reduction in labor cost. This over the years has been the standard reason for new acquisitions.

2. Longer reach or other range not possessed by previous designs. Examples are strip shovels and draglines able to handle deeper overburden and thus increase the reserves that can be stripped at the same low cost.

3. Lower breakdown time and lower repair cost. This has recently moved much more into the limelight as a reason for expenditures. A simple example illustrates the point. If a miner costing $120,000 was able to work only 60% of the time and produced 400 tons per shift with a section crew of six, direct labor would be $0.37½ per ton. But if, by spending another $40,000 for a troubleproof design, breakdowns could be eliminated to the extent that an 85% working time was possible, production per shift would jump to 570 tons and direct labor would drop to $0.26 per ton. The saving per shift would be $63, or $26,460 per year of 210 double-shift days, in addition to a substantial saving in parts and maintenance labor.

Even if the more costly unit did not produce more coal it might be warranted under some circumstances by maintenance savings (parts and labor) alone. If, for example, a loader was producing 300 tons per shift and maintenance could be cut from 11c to 7c per ton, the saving in a year of 210 double shifts would be $5,020.

Cost Control

EFFECTIVE CONTROL of costs has been proved as to practicability and results, the latter running to cuts of 25% or more in overall mining costs and up to 50% or more in face costs. Collateral benefits include ability to forecast costs, plan such operations as haulage to make them better, organize shop work for greater effectiveness, streamline paper work, and estimate the effect of nonroutine jobs on costs.

BUDGETING—There is nothing more basic in cost control than setting down the production desired and the money that will be spent to get it—item by item. Otherwise control is merely stabbing in the dark. Budget systems and forms naturally will vary but the principles and functions are basically identical. Usually the keystone is an annual budget showing sales expected in tons and the normal expenditures—labor, material, power, taxes, etc.—expected in the production of this many tons, plus the expenditures involved in any special jobs that may be scheduled for the year. For more precise control, the yearly budget then is broken down into monthly budgets and perhaps even into weekly in addition.

Costs used in budgeting should be standard costs derived from time and methods studies.

DATA PROCESSING—One of the keys to budgeting effectiveness is comprehensive data on performance with a minimum time lapse. The report system supplementing the budget should provide the necessary data on production delays and cost details, which then should be combined and summarized without delay to uncover any adverse deviations from expected performance and permit remedial action. Machine processing of reports is the big answer to accurate data promptly—and incidentally with a minimum of clerical labor. In the larger operations computer centers incorporating several machines are the answer. But whatever the size, there is a

system and equipment that will provide the data necessary for control quickly, accurately and cheaply.

STANDARD DATA—Making an accurate budget and achieving accurate control over costs presupposes accurate information on the cost of each individual activity entering into the overall budget total. Time and methods studies provide this information, frequently known as "Standard Data." But even before these data are secured the industrial-engineering approach should lead to development of the most efficient working setups, as briefed in the following section.

METHODS REVISION—Getting the maximum efficiency and the lowest cost involves studying the operation as it is being conducted, then taking it apart and setting it up in a new form to eliminate all possible delays and bottlenecks—again the objective of the industrial-engineering approach. This approach can be applied to any operation, including, as an example, maintenance, and also can be used to evaluate the possibilities of new equipment and new systems. Time study is the principal tool, and the same time-study approach can be used after a change has been made to check as to whether or not the desired results are being achieved—and if not, why not.

OPERATIONS RESEARCH—The methods revision approaches outlined in the previous section are a simplified form of an increasingly used technique called "Operations Research." It involves setting up a mathematical model of the particular operation being sudied, developing the proper formulas, and then calculating the results. For a fuller description of the theory and how it can be applied to mining operations, see the February, 1960, issue of *Coal Age*, pp 104-110.

A major advantage of operations research, plus use of the computer for calculation, is its adaptability to providing, quickly and easily, precise data on the results of changes in methods or equipment—say the number of shuttle cars serving a miner.

INCENTIVES—With a budget, and with time and methods studies providing the most efficient production setup and an accurate measure of what performance could and should be, management then is in position to adopt an incentive-pay system or systems to further enhance the benefits. The incentive system may be limited only to supervisors, which is the common practice in coal mining, or it may, as in some instances, take in both managment and men.

Incentive payments differ from bonuses, such as Christmas and profit-sharing, in that they are paid on definite measured performance by each individual and thus directly reflect effort and skill. They involve (*Coal Age*, January, 1958, p 104; October, 1958, p 86) the establishment of definite standards of performance, proper application of standards, controls to make sure that safety and other factors are not shortcut, and capable personnel to administer the plan. This approach also eliminates the possibility of falling into the error of trying to accomplish with incentives the improvements that management should normally have made in operations. The goal of incentives is to get men to work harder and better after the operation has been brought up to "normal" efficiency.

Supporting Steps

AMONG the supporting steps that can make wise investment and a good cost-control setup more effective are the following:

TRAINED MEN—This does not mean only formal courses or schooling, though those that have installed such courses report that they are well worth their cost. Since their responsibilities are greater and their proficiency or lack of it is much more a factor in the profit-or-loss picture, training of managers and supervisors normally has priority. Methods simplification, for example, is one form of such training, which some companies are finding very worthwhile. The growing importance of maintenance has been marked by a substantial increase in formal and informal training of mechanics and electricians.

Formal training of certain machine operators and other workers is not too frequent, but here the informal type administered by the trained and capable supervisor can pay dividends.

RATED VOLTAGE—Not only does voltage less than nameplate rating slow down equipment—particularly DC—it also breeds a don't-care attitude among crew members and burns out armatures, coils and so on. This increases maintenance cost and ups section or pit cost. The power setup should provide rated voltage at the machine terminals. Attaining this goal should be a concern of all operating, electrical and maintenance officials.

EXPERT MACHINE CARE—Low cost today depends even more than ever on keeping machines running at rated capacity as much of the time as possible. Stoppages resulting from machine breakdown result in as much idle time as any other cause.

As noted in the "Investment Policy" section, considerable extra investment is warranted as a basic approach to the problem. Beyond that, skilled preventive maintenance should be the rule to enhance the original benefits. A good repairman should never be too far way, even if not actually stationed in the section, but the goal should be to make it unnecessary to call him for actual repair. Rather, the emphasis should be inspecting and checking to catch trouble before it starts or make repairs when they take only a few minutes, rather than the lengthly periods required for major breakdowns. It helps, too, when foremen and operators have some degree of familiarity with machine design and preventive-maintenance methods, including good lubrication.

SUPPLIES WHEN NEEDED—Small breakdowns can have severe consequences when it is necessary to send outside or to some distant point for a part that should have been in the section or pit stores. The moral is to make sure that supply items of the right type are at the right place at the time they are needed. This includes even mine props, roof bolts, rail, ties and anything else the lack of might slow down or stop production.

TRANSPORTATION WHEN NEEDED — Underground, "continuous" transportation is provided by conveyors—and to some extent, but growing, in stripping. However, depending upon the type of production and haulage facilities, shuttle cars and rail cars can provide the equivalent of continuity underground under most circumstances.

The need for "continuity" also applies to mainline haulage, which should be set up to have an empty trip at each transfer or loading station before the previous trip is loaded out. The same reasoning also applies to truck haulage from strip pits. Underground, also, transfer of coal to cars should take place without delaying the shuttle car or conveyor, meaning that facilities should be provided for shifting cars while the coal flow continues, unless, for example, shuttle-car and mine-car capacities are identical.

SAFETY ALWAYS—Last but no means least in any list of guideposts to efficiency in operation is constant emphasis on safety. Aside from everything else injuries cost in increased compensation and medical payments, in lost output and, very frequently, in damage to mine and equipment.

Safety and high production can and should go hand in hand. At one deep mine running 108 tons of material per faceman, the 1960 frequency rate was 4.05, and the severity rate 0.37.

The Deep-Mining Guidebook . . .

Low-Cost Development

Since 1955

Major increase in "punch" mining, using both conventional and continuous-miner units.

More development based on shaft hoisting than in immediately preceding years, though drifts and slopes remain the dominant types of openings.

Drilling of air, supply and emergency shafts increases.

Retreat or combination advance and retreat even more firmly established as the basic mining approach.

Ahead to 1965

Development from outcrops and final strip cuts to show a major increase, with R-C (remotely controlled) equipment coming into use in competition with miner, loader and auger units.

Activity in development of new mines will be marked by further increase in number of deep shafts, though slopes and drifts will remain dominant.

Continuous miners and big drills will be employed more widely in sinking main shafts and slopes, with special muckers employed where drilling and shooting still is the practice.

Except where R-C or auger units are employed, room-and-pillar will continue almost without exception as the basic mining system.

Locating the Portal

LOWEST COST over the life of the property is the major consideration in portal location. At better than $3 an hour for travel, this item alone emphasizes the need for thorough study of location. Favorable haulage and drainage grades, and keeping haulage and air travel to a minimum, are other considerations. These same factors, and any others that may be pertinent, may result in a decision to start with one opening and make others as time passes. In some instances, after, say, 20 yr, it may be more economical to build a complete new plant at a new spot.

Drilling is a major tool in establishing grades, coal thickness and quality, all of which are factors in design and portal location. Depth of overburden determines the number of holes economically possible. In average hilly country, one up to 500 to 600 ft deep every 5 or so acres is fairly common practice. If the coal is over 1,000 ft down, only an occasional hole is possible, but even this can provide some assurance that there are no major wants or faults, and in addition yield elevations and cores.

Waterside or near-waterside location is highly desirable today, and may warrant an overland haul of up to 10 mi or so for 1 to 2 million a year, and up to 25 mi or more for over 2 million, assuming simple construction over fairly easy terrain—not mountain road with heavy cuts, steep grades etc.

Water supply and room for storing raw and prepared coal are other location factors, along with parking and other space. Storage of coal at the mine is a practice that will become even more necessary in the future, and will involve even larger tonnages.

Sinking and Tunneling

ROCK SLOPES—Rock slopes today normally are designed for belts, and thus are inclined less than 17 deg as a rule. Hand mucking may be employed in sinking, but is the most costly. Loaders therefore are the rule. They may be special rock machines, such as, the slusher, or standard coal machines temporarily pressed into service. Some slopes have been sunk in the past with boring-type miners, which should provide the fastest rate of advance and the lowest cost, provided the strata is such that hard cutting is limited.

With the mucking medium settled, the next big question is transportation. The methods include:

1. A muck car and hoist. Whatever, the system, incidentally, a bin and disposal system (normally trucks) is essential on the surface, along with other facilities.

2. Conveyor hoisting—either a temporary chain setup or a chain unit feeding onto the main slope conveyor erected as sinking progresses and perhaps fitted with a temporary belt.

3. Special units, such as, a modified extensible belt which, in one instance, using a loading machine, resulted in sinking rates (9x18-ft opening before lining) of 4 to 10 ft per shift.

For steeper slopes, aside from hand mucking a "helldiver," *Coal Age*, May, 1951, p 100) may be employed, or one of the new track-mounted grab-type machines may be installed.

COAL SLOPES—With machine loading, about 20 deg is the limit for inclination, even though the machine can be maneuvered on steeper slopes. This also is the limit for most conveyors, though special chain-and-flight types have been used for hoisting up to 45 to 50 deg. Special mucking units for high inclinations include the "helldiver."

RAISING SLOPES—Machine loading is as desirable in raising slopes and airways in coal or rock up to, say, 20 deg, as in sinking or work on the level. The preferable transportation medium is the conveyor up to the point the material will begin to run on sheet iron (about 30 deg). At about 35 to 40 deg coal will begin to run on bottom rock, and above approximately 45 deg, checks or batteries are required.

SHAFT SINKING—As with rock slopes, unless enough work is done to employ specialists full time, contracting is the best way of getting major shafts constructed. But if done by the mine organization, and the shaft is big and deep, mechanized mucking facilities should be employed—crawler-type front-end loaders with electrical power, special cage-mounted muckers, etc.

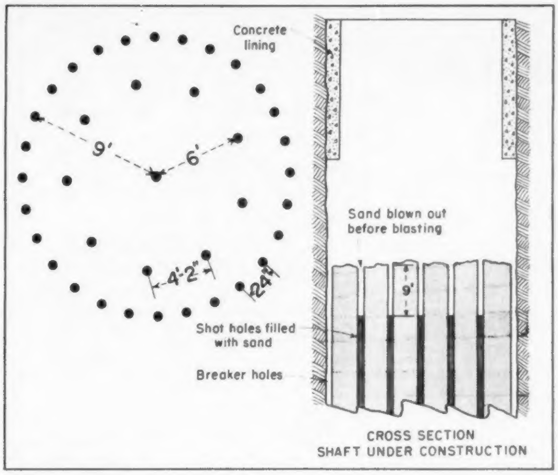
Where shafts are shallow, outlining by drilling (*Coal Age*, April, 1955, p 74; June, 1958, p 106) and mucking with a clamshell results in high speed and low cost. Cost of one such shaft, with lining, was $289 per foot.

Drilling is an increasingly popular method of putting down auxiliary shafts for air, supply handling and emergencies. Cost of two such shafts in the past, 36- and 48-in, including site preparation and road-building were $107 and $125 per foot, no lining. The shafts may be drilled in multiple and pilot holes plus service holes may be employed to materially speed up the operation.

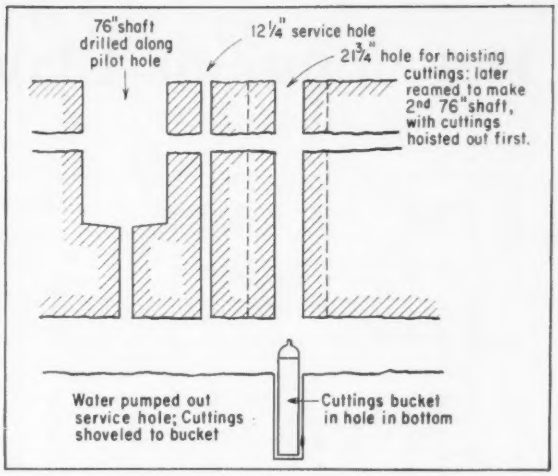
ROCK TUNNELING—Even though not designed for such duty, coal equipment often is pressed into service where rock tunneling is a special job occurring once in a great while. Where rock tunneling is extensive and frequent, however, special rock equipment provides better results. In addition to coal-type machines modified for rock work, equipment includes overshot-type loaders and slushers or scrapers of the 2- and 3-drum type, the latter providing a greater degree of flexibility in covering the entire face.

Mine Projection

FULL-RETREAT MINING, meaning mining from the boundary back, is the ideal system with exceptions so few as to be almost negligible. But more time is involved,



OUTLINING BY DRILLING cuts cost of sinking shallow shafts by up to 50% with new grouting, mucking and lining techniques.



PILOT HOLES facilitate big-drill sinking of a pair of man and service shafts. Center hole serves for power and water.

even with the high speed possible with today's equipment, so combination advance and retreat has become a popular system. One side of the area, or even of the entire mine is worked on the advance, providing quick coal at full rate and normal costs. The other side is worked on the retreat. Variations in the basic approach are several. For instance, the main opening may be placed in the center of a large tract, which then is recovered by quarters, with full retreat, or advance and retreat, in each such section.

Where full retreat is the goal and quick coal is desired, a special section or sections adequately isolated may be provided. In hilly country, also, augering or other exploitation of the outcrop can achieve the same goal. Of course, in hilly country, the entire output may come from punch or contour mining setups—fully mechanized with either conventional or continuous-miner units.

CLOSED V. OPEN PANELS—One question in setting up a mining projection is whether to aim for complete isolation of each working section by the use of closed panels. When trouble comes it is kept within the closed panel, which also is easy to seal. But it makes for more difficulty in mining and pillaring, and does not permit the use of bleeder entries, now preferred by the majority of operating and safety men. The bleeders or other special openings also provide alternate escape routes.

What might be termed "slicing" is a growing practice in the establishment of individual working sections. Some examples of such sections appear in the accompanying Development Planbook, as well as in the Continuous-Mining Planbook in the following section. In essence, slicing consists of driving up some 4 to 6 "rooms," which really are more like entries, and then bringing the pillars back on a flat or angle line, more frequently the former. Then a suceeding "slice" is developed and mined.

PILLARING PRACTICE—The emphasis today is definitely on taking pillars, though with augers and similar units, including R-C (remotely controlled) miners, ribs must be left of necessity. And if the coal is thin, adding to the difficulty of mining, and the top is good enough so that pillar size may be cut down to a minimum, the tendency is to leave pillars. Bad top may also result in leaving coal. But, unless coal must be left, failing to recover, say , a third, means driving, equipping, supporting and maintaining a third more rooms and other entries for the same tonnage.

Square or nearly-square blocks are more and more the rule in designing pillars. Angle driving may be employed in some instances to yield "diamond" pillars, which tend to favor boring-type machines and also shuttle-car haulage and equipment travel. But in many instance the pillar is square but the pockets for extraction are driven on an angle. Rectangular pillars still are widely employed, however, especially with boring units, which angle through in many cases in final extraction. Very-thin pillars, if possible, may be desirable. One operator thins them down to two cuts, slabbng them once on final retreat and leaving the remaining one-cut thickness.

Entry Driving

NUMBER OF OPENINGS becomes possibly the first question in developing an entry-driving program. In moderate to steeply pitching coal, the difficulties of developing under such conditions normally limit the number of two—a gangway for haulage and an airway above. At a fair number of collieries, gangways in coal have been given up in favor of rock tunnels underneath the vein, though the airway, as a rule, still is made in coal, with connections for mining and ventilation through rock chutes.

In lighter-pitch coal, conditions are more favorable to increasing the number of headings, though the general practice is to keep the number as close to two as possible. At pitches of up to 10 to 15 deg, the possibilities of both development and room work with continuous miners have definitely been proved. A popular system is driving across the pitch with conveyors, then working rooms one at a time up the pitch, the miner discharging to a conveyor in the place, which in turn discharges to the loading conveyor in the lower gangway.

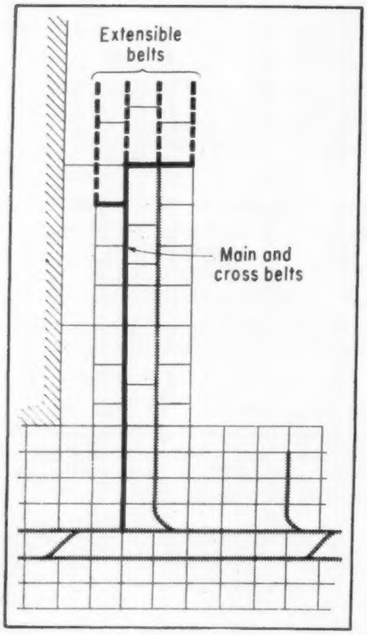
HEADING NUMBER—Airway area is one factor in the establishment of the number of headings in flat coal mining. Thus, if large volumes are necessary and if the coal also is thin, more headings may be a necessity. An increased number of headings also is sometimes desirable to provide enough working places so as not to handicap the entry-driving unit, especially if it is of the conventional type.

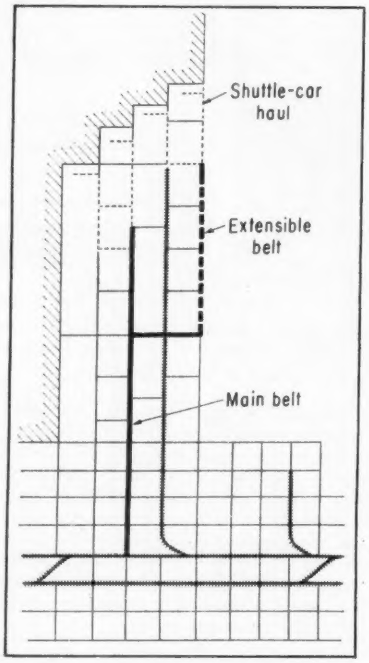
Use of continuous miners, and also of bridge-conveyors, is reducing the need for increasing the number of headings for the sake of lowest face cost. They frequently make possible the same outputs with fewer openings. Nevertheless, there is a growing tendency to go up to eight or more headings for mains, and to drive 3 or 4 in room territories (or 4 to 6 in the "slicing" systems previously discussed). Experience seems to indicate that numbers such as these give low cost and flexibility, as well as good airway volume.

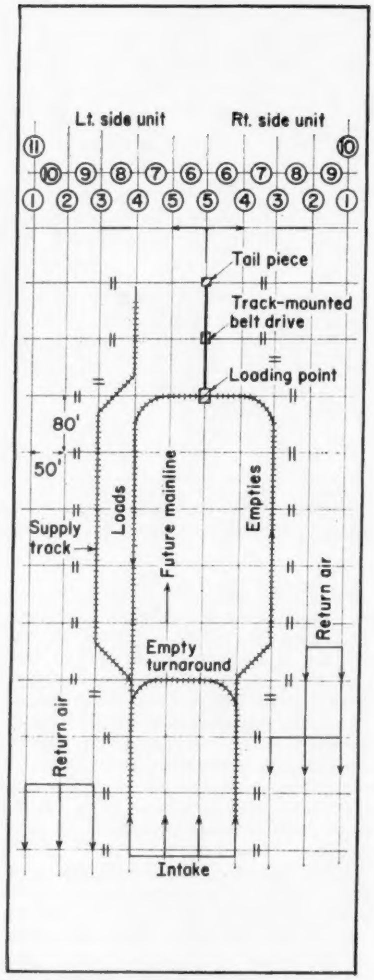
ENTRY-DRIVING SETUPS — Various schemes for developing entries with either many or relatively few headings are shown in the accompanying Planbook. A number are especially developed to cut travel distance when machines must shift from place to place, which usually is the case. Loop-track systems for serving the driving units with mine cars are increasingly popular, and examples are included in the list of plans. Some involve cross conveyors, and some a combination of bridge, bridge-carrier and chain conveyors to bring the coal to a central point.

In driving cross-measure openings in pitching coal, one of the more troublesome is making crosscuts between gangways and airways. Drilling with a big drill head (*Coal Age*, May, 1951, p 100; August, 1955, p58) or a modification of a highwall auger is a low-cost, convenient method.

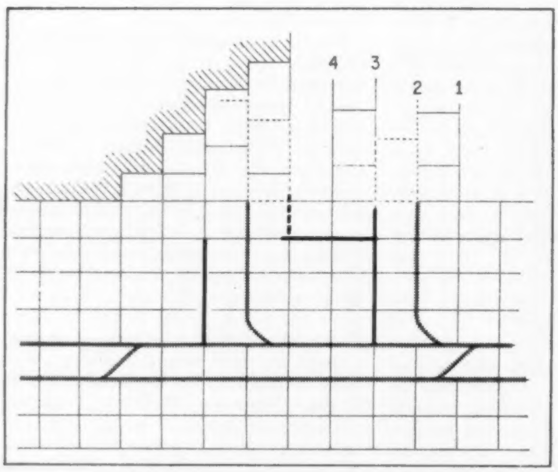
Development Planbook



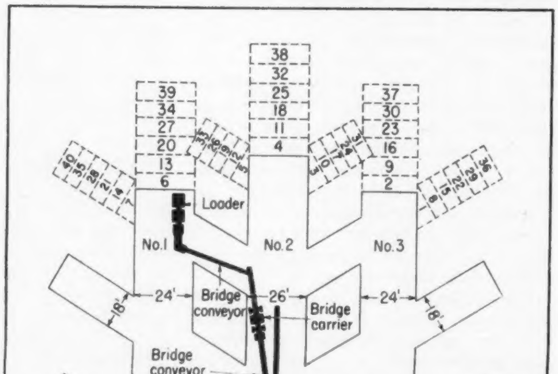




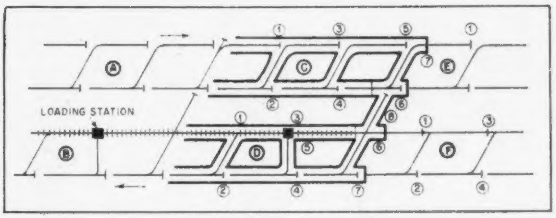
MAIN-ENTRY PLAN shows sequence of advancing headings with two continuous miners, track and belt setup, and ventilation.



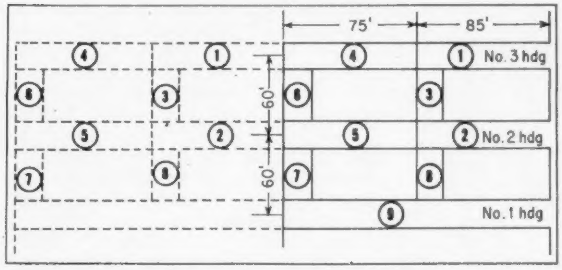
FOUR MINERS served by single shuttle cars, extensible belts and cross belts develop four headings (upper left diagram) in this plan. In retreat (upper right diagram), since it is necessary to remove equipment when the roof starts to work, only one extensible belt is used and a second shuttle car or surge loader is used behind each machine. To change from pillaring to development of a new section (lower left) a spare main belt is installed to start the new panel, with a cross belt to permit completion of the old.



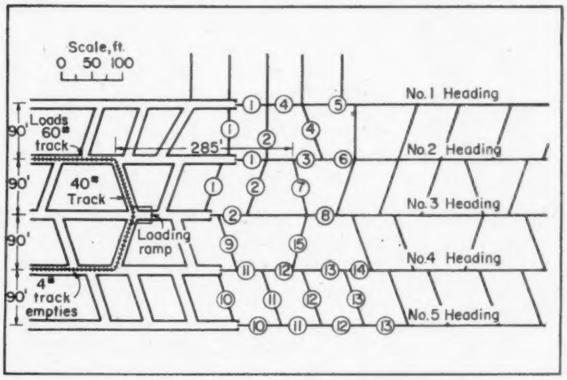
FORTY CUTS per loading-point advance without panning up or conventional conveyor moves are possible with this combination of bridge, bridge-carrier and chain conveyors in three-heading setup.



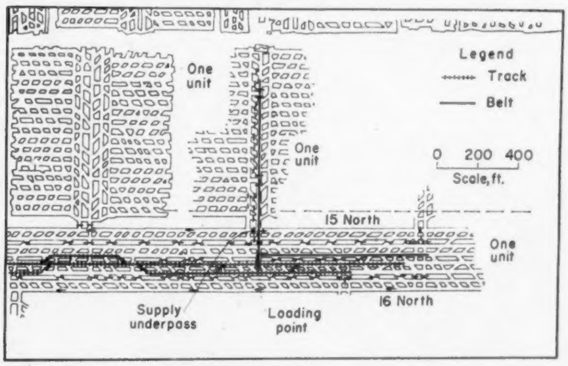
FOUR-HEADING MAIN ENTRY for development with boring-type continuous miner. Alternating from left to right the sequence of advance is shown by the letters and numbers. One objective is to keep shuttle-car tramming distance down.



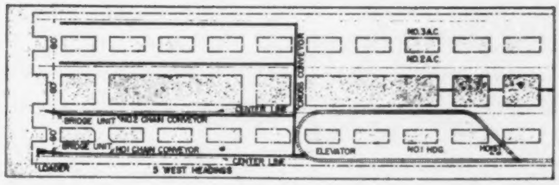
MINING SEQUENCE in room panel includes nine separate moves, starting in No. 3 heading and ending in No. 1, using boring machine.



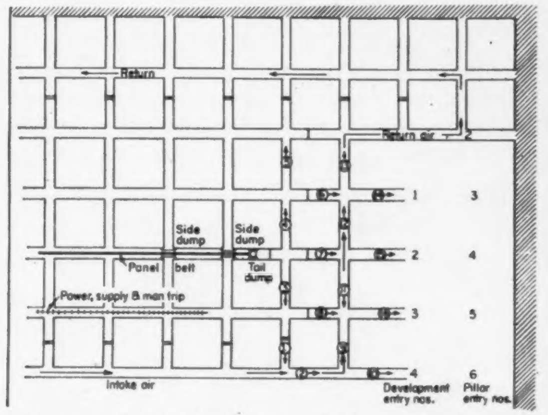
DEVELOPMENT PLAN for five-heading flat entry, boring machine and loop haulage. Loops are advanced every 285 ft. Circled numbers show mining sequence.



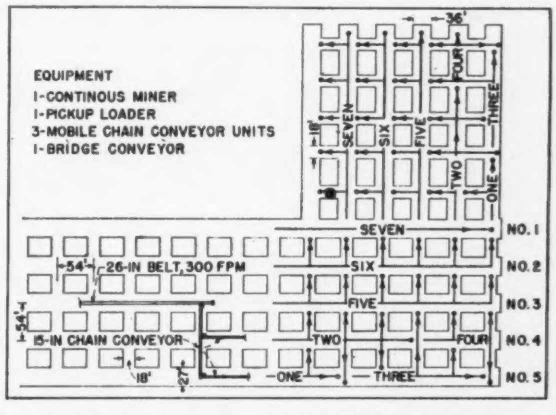
CONCURRENT ENTRY DRIVING features this panel plan with three loading units feeding via belts to a single-car-loading point. Doors and checks are eliminated along shuttle-car hauls.



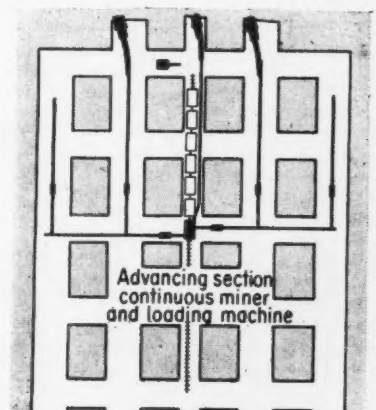
BRIDGE CONVEYOR-LOADER SETUP with loop track for cars is one of the entry-driving systems providing maximum advance with minimum cost. Cross conveyor brings coal from all four places to car-loading elevator.



FOUR-HEADING ROOM-ENTRY PLAN of the "slicing" type for boring-type miner with ropeframe conveyor. Four rows of pillars are removed on retreat out of the section after completion of development.



MINING PLAN with continuous miner, pickup loader, bridge and chain conveyors designed to keep moves to a minimum.



ROCK LOADER advances center heading, and auger-head miners with bridges each pair of side openings.

The Deep-Mining Guidebook . . .

Continuous Mining . . . Equipment, Methods and Results

Since 1955

Number of machines in service has slightly more than doubled, but total output has tripled, reflecting the capacity increases achieved through design improvements and more skill in operation.

Design activity has resulted in accelerated introduction of miners for the thinner seams, thus providing thin-coal operators with the efficiency and cost benefits of continuous mining.

Further experimental work is throwing more light on the possibilities of R-C (remotely controlled) mining, longwalling and hydraulic mining.

Ahead to 1965

Actual commercial use of R-C mining and its growth to significant tonnage, as well as the start if not completion of re-engineering to permit the use of the same principle underground over much-longer distances than now possible with other means, such as, augers.

Probable refining of principles, practices and equipment to achieve workable longwall for U. S. conditions.

Commercial production of coal in some quantity by hydraulic methods—particularly in pitching coal in the anthracite region and elsewhere.

SOME 800 continuous miners were in use underground in 1960, against only a few in 1950 and 385 in 1955. Thus, much of the past 10 yr can be described as experimental, with heavy concentration on new designs and improvement of those originally adopted. This new and redesign still is going on, though major progress has been made, as evidenced by machine output. In 1952, when 152 machines were in use, annual output per machine was 540,000 tons. In 1955, it had risen to 710,000, and in 1960 a preliminary estimate indicates that miners today average over 1,000,000 tons per year.

Some of the findings of this trial or experimental period are throwing some light on the proportions of coal that eventually will be produced by continuous and conventional units, though it also can be accepted that conventional tonnage will continue to decrease and perhaps eventually disappear altogether. But for the present, convntional units are more than holding their own under certain conditions. Among these conditions are:

Considerable thickness variations and the presence of heavy partings in some areas but not in others.

Variations in coal quality. Conventional units, where concentration is not so vital, can be scattered to balance the raw-coal output.

Existence of a substantial coarse-coal market. A coarse product also can simplify and cheapen the preparation process, especially if the ash content of the raw coal is such that separate coarse and fine-coal facilities, with thermal drying, are necessary. The coarse-coal facilities cost less to buy and operate.

Heavy spraying with miners can result in dust rideover in preparation, adding to clarification and fine-coal moisture problems.

Capital costs per unit may be higher and productivity less, requiring more miner units and more money, even though higher tons per man are secured.

Usually, however, not all of these adverse factors are encountered at one time, and normally the higher concentration possible with the miner and its smaller crew pays off in lower face cost, especially if the proper follow-through is achieved. Some of the key items in follow-through are as follows:

DESIGN TRENDS—Actual continuity of operation with a "continuous" miner is dependent upon a number of factors, some inherent in machine design and some a result of the need for certain auxiliary operations. Auxiliary operations that may interrupt continuity include shifting of position or place to permit roof-bolting, timbering, and advancement of canvas or tubing; intermittent haulage; inspection, checking and lubrication; breakdown and major overhaul, etc. Machine design itself may make the mining operation an intermittent one because of the necessity for dropping the head, opening the arms bearing the cutting heads, and so on. And machine design has a major bearing on breakdown and overhaul time and expense. This latter is the objective of a major drive.

With all other conditions taken care of, full continuity of operation is achieved with a continuously operating set of crawlers constantly moving the machine ahead. This presupposes a cutting head that will keep the coal mined as the unit advances. The boring head is one type, and for this reason as well as others has come strongly to the fore in recent designs—even to the extent of employment of boring heads on the arms of certain intermittent-action units.

Continuous Systems

Among the basic considerations in developing a continuous-mining plan are:

1. A layout that insures continuous or nearly continuous transportation availability. The conveyor of course provides the maximum in continuity, but as in conventional mining the difficulties in its use, includng moving and extension, have kept the shuttle car to the forefront as the principal unit for use directly behind the miner. However, heavy stress on design and development in recent years on extensible, bridge, mobile and other units more suited for face service has resulted in acceptable systems and units, with good prospects for others in the future.

With shuttle cars in the majority, much emphasis has been placed on number, routing and so on the achieve maximum service to the machine. Operations-research principles and computers are being employed to quickly pick out the system with the best possibilities under a specific set of conditions, thus eliminating the time and expense of field trials. And old-reliable methods of offsetting some of the unavoidable delays in the use of shuttle cars is the pickup loader.

2. A layout that cuts equipment moves to a minimum—and keeps the distance down when such moves must be made. Ventilation and roof support are factors in achieving the final mining layout, as is also the ability of the machine to cut part or full place width. Full-width cutting and bolters on the machine itself help to a considerable extent in roof support; likewise tubing and blowers in face ventilation. But in spite of all these, it seems apparent that some moves will have to be provided for for some time to come.

3. A layout that facilitates getting the necessary air to the working face and eases the dust problem. In addition to the gas and dust problems and hazards, the method of ventilating faces may have, as previously noted, a considerable influence on number of machine moves. A full discussion of systems and equipment for attaining the desired ends in face ventilation appears in the *Coal Age* Special Report, "The ABC's of Ventilation for Continuous Miners," February, 1959, p 97.

PANEL PLANS—Room-and-pillar remains almost unchallenged as the basic working-section plan with continuous miners. Long experience has shown it to be, under U. S. conditions, simple and flexible, in addition to easing the problem of roof support. This lead should persist.

Full retreat, or advance on one side and retreat on the other, are the two most popular panel plans. Three headings per panel entry are customary, with 4 or 5 in a limited number of instances. Bleeder openings for improved ventilation and emergency escape are an almost universal practice in many areas of the country.

SLICING SYSTEMS—Not yet widely used but increasing in application is "slicing," or driving up 4 to 6 places the set or desired distance, which may be 1,000 ft or more, and then pulling the pillars on the retreat. After completion of one slice, the unit moves over and mines another along the gob. A bleeder opening may be established by leaving a row of blocks along the gob for recovery on the next slice, as shown in one of the plans in the accompanying Continuous Mining Planbook." Simplicity, speed and flexibility are among the big advantages of the slicing system.

"SPECIAL" SYSTEMS—In addition to slicing, the systems differing in some marked degree from what might be termed "standard" panel plans include the three shown at the end of the Continuous Mining Planbook. In one, based on the use of extensible belts, extra-deep rooms are driven with a boring-type miner. After the miner moves the coal is cut 11 ft deep (in this particular instance), and then is shot and loaded onto the extensible belt.

Also based on the use of an extensible belt, a second plan contemplates places 1,000 ft deep. Pillars are taken on the retreat in two stages—first a slab off the pillar on the solid side, then final extraction of the partial pillar on the gob side. When extraction is completed, the miner leapfrogs the next place, already driven, and drives up the third one. Miner and head and tail sections of the belt then return to complete No. 2, in which extra belt and stands are in place.

Extra-long rooms driven in pairs with thin pillars feature a third plan, using a rope-frame conveyor to serve the miner, plus shuttle cars for recovering chain pillars from the previous panel. Thick pillars between the pairs of rooms are extracted by slant pockets separated by thin wings. A modification of this twin-room system for shuttle-car service is shown elsewhere in the Planbook.

Field Reports

Twin-Room Development—Plan for boring units, 7-ft mining height, employs pairs of rooms with thin pillars. Thick pillars between pairs provide for the final mining step, accomplished by angled pockets and thin wings. *Coal Age*, July, 1960, p 100.

Haulage Revisions for Higher Miner Output—Productivity of boring units in 39- to 42-in coal increased 20 ft per shift by articulated shuttle cars and new belt conveyors. Panels mined one side advancing and the opposite retreating. Angled lifts employed in pillar extraction. *Coal Age*, September, 1960, p 102.

Industrial-Engineering Groundwork—Time and methods studies covering ripper, boring and milling-head miners resulted in such achievements as 877 tons per shift in 60-in coal, with the help of new differential-rate feeders at belt transfers, plus overhaul of shuttle-car travel routes. Production of as much as 209,011 tons in two-shift operation without a breakdown or major overhaul also marked up. *Coal Age*, December, 1960, p 80.

Yielding Jacks in Pillar Mining—Pocket-and-wing pillar extraction with ripper and boring units facilitated by hydraulic jacks. In the "slicing" system employed, four places are driven up and the pillars pulled on retreat, using two miners and leaving bleeder for the next slice. *Coal Age*, February, 1961, p 70.

Higher Productivity, Greater Safety—Four boring and one ripper units in 6-ft coal provide, in addition to increased productivity, better roof and ventilation. Heading advance with nine-man crews is 140 to 150 ft per day, with 170 ft in room headings and 200 ft in rooms and pillars. *Coal Age*, April, 1961, p 72.

Thin-Seam Extraction—New machine with barrel-type cutting heads on scissors-action arms mines better than 300 tons per shift in 36- to 41-in coal with seven-man crew. Special room plan features four-step mining, which provides two shuttle-car roadways. *Coal Age*, May, 1961, p 91.

Pillaring Approaches

Though there were a few examples of long pillar lines extending over several panel entries in the early days of continuous mining, the modification of the earlier systems to fully utilize the potential of the continuous machine has been marked by an almost complete shift to a small number of places and short lines. In advance-and-retreat panels, for example, only a single place may be driven and the pillars next to the gob brought back to the entry before starting the next place. In the new "slicing' systems, up to 4 to 6 places may be driven, meaning that 4 to 6 pillars are mined on the retreat—sometimes with two or more machines. The short pillar line may be angled or flat. Among the advantages of operating with a small number of openings is less trouble with roof, fewer falls and a lower support cost.

Square or nearly square blocks are popular today, though the rectangular block still is found in large numbers. In addition to posts, bolts, crossbars and cribs, yielding hydraulic jacks are being found a very helpful device in pillar mining. Open-ending is less frequent yielding to thin fenders or wings thick enough for supplementary passes after driving the pockets.

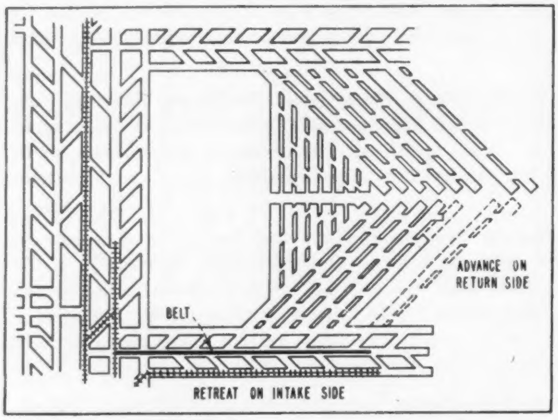
Pitching Coal

With some variations depending upon machine type and natural conditions, standard continuous miners can work up and down pitches of up to approximately 20 deg. Entries naturally are driven on the level and rooms are turned up pitch in usual fashion, except for perhaps some modification in centers to facilitate pillaring, if done. Of course, if the continuous miner is limited to entry-driving alone it can be used in coal pitching up to 90 deg.

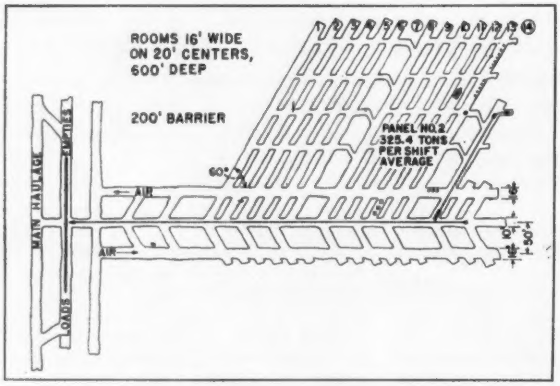
Suggested plans for using continuous miners in coal pitching more than, say, 20 deg include driving long places across the strike, using an extensible belt, and then drilling and shooting the up-pitch pillar, starting at the inby end of the place and using the miner as a loader in picking up the coal if it is of the type equipped with loading arms. Otherwise, a standard loader could be brought in for this phase of the work.

Another suggestion is drawing gangways with the miner and then using an underground auger to recover coal in the up-pitch pillar.

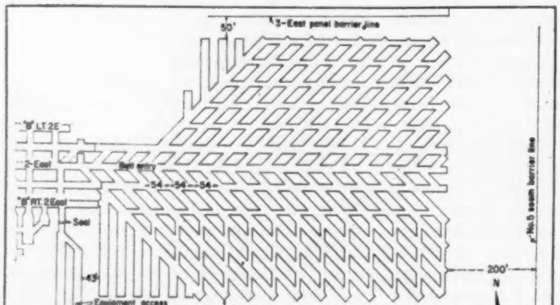
Continuous-Mining Planbook



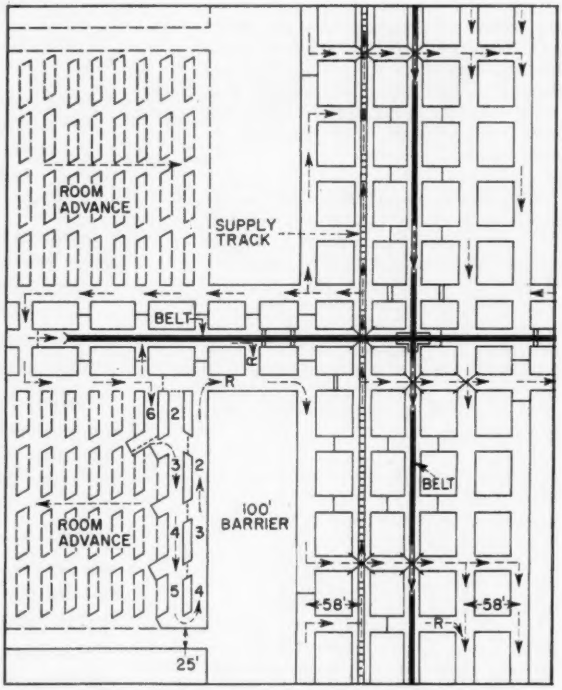
ANGLE PLAN with shuttle-car and belt haulage. Rooms are worked advancing on the return and retreat on the intake. Stub rooms are driven to mine the triangle formed in this project.



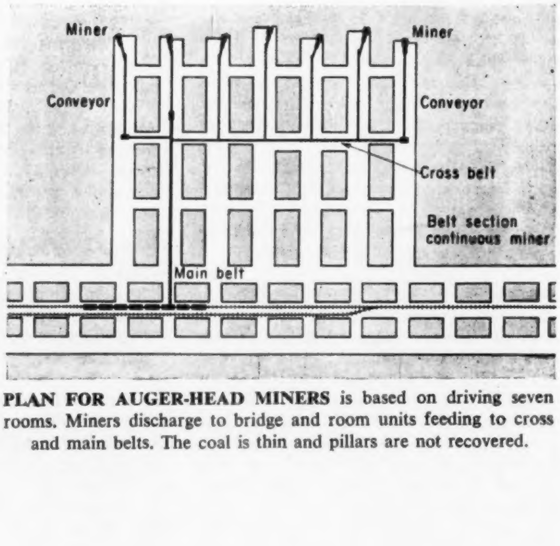
ADVANCE ON ONE SIDE of the panel and retreat on the other distinguishes this room plan for ripper-type units. The mining sequence in the first two rooms establishes the cross-cutting pattern for subsequent places.



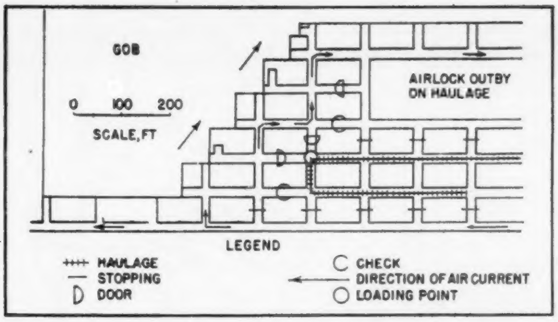
ANGLE PLAN with haulage by extensible belt, advance on one side and retreat on the other, ripper-type machines. Rooms are 600 ft deep.



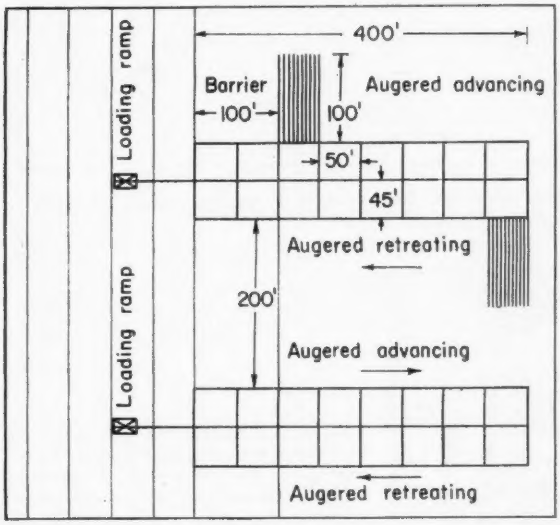
45-DEG TURNS permit full utilization of boring head. Rooms and pillars are mined on one side advancing, and on the opposite side retreating. Mining is always toward fresh air.



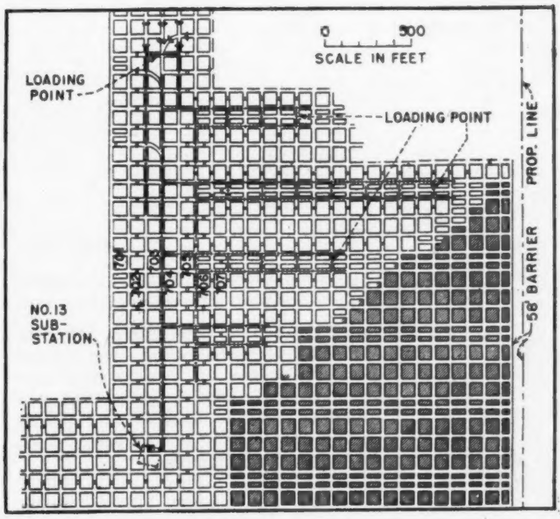
PLAN FOR AUGER-HEAD MINERS is based on driving seven rooms. Miners discharge to bridge and room units feeding to cross and main belts. The coal is thin and pillars are not recovered.



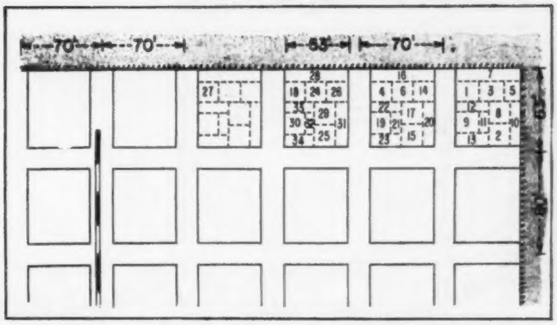
"SHORT-ROOM" PLAN for semirigid head machines employs rectangular pillars. There is little basic difference between development and room work in this system. Loop track facilitates haulage from shuttle cars.



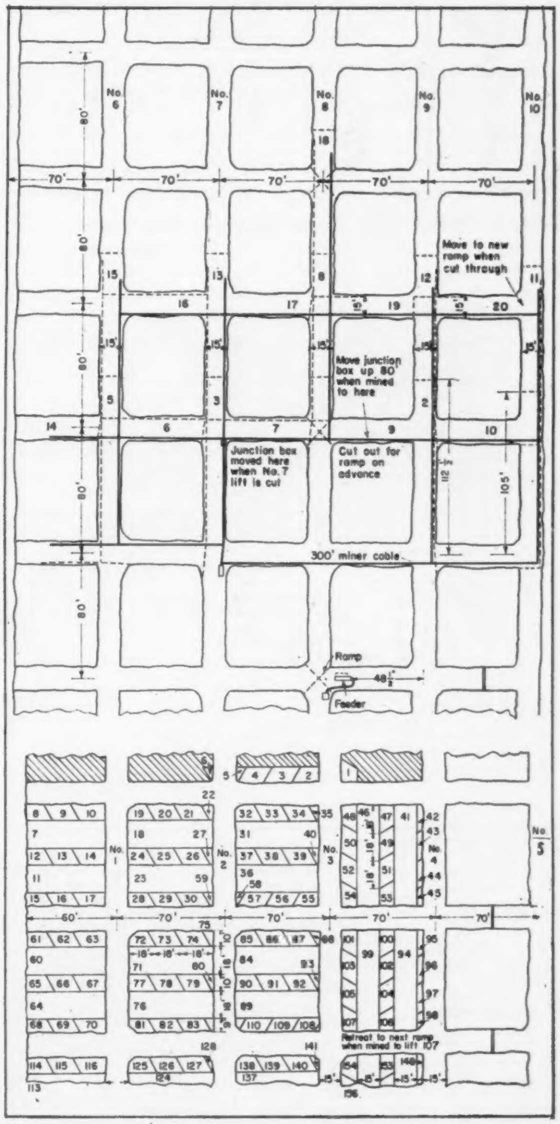
UNDERGROUND AUGER SYSTEM involves drilling on one side of panels on the advance to depth of 400 ft and then retreating on opposite side. Auger holes are 100 ft deep, with 6 in between.



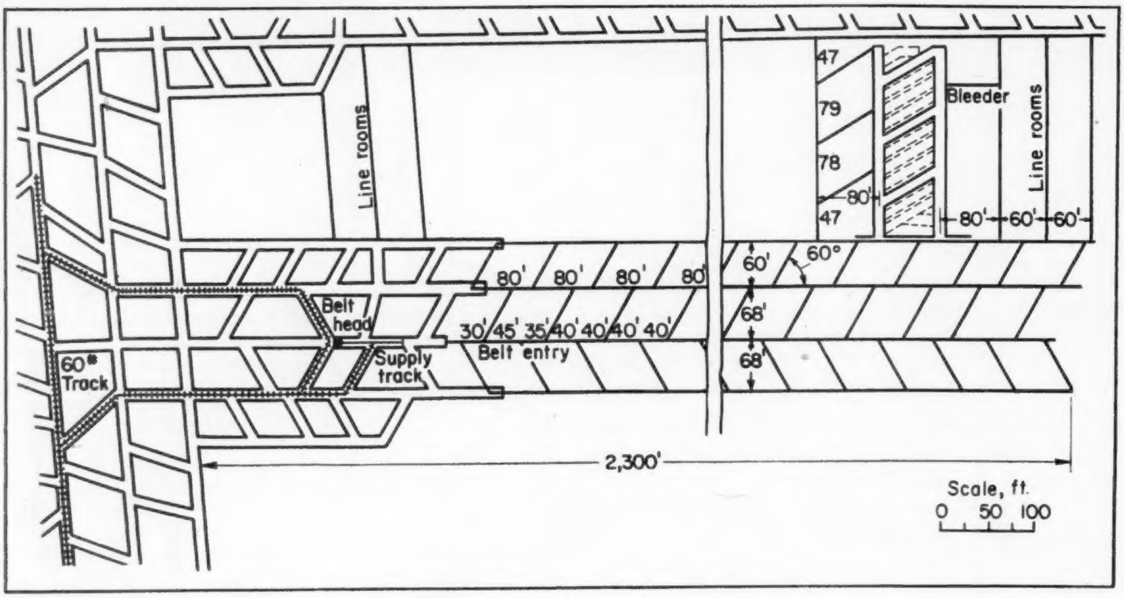
STEPPED PILLAR LINE—Long pillar lines are the exception rather than the rule, and where used frequently are stepped, as in this plan, each step constituting a section for a ripper-type unit. Loop-haulage system eliminates car-change delays at loading points.



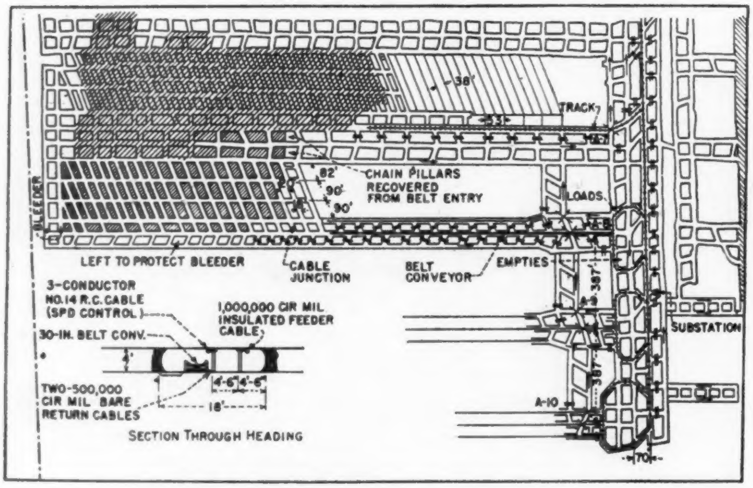
BARRIER RECOVERY PLAN (barriers 500 to 700 ft thick) with semirigid machine. The rectangular blocks are mined from two sides in the sequence shown.



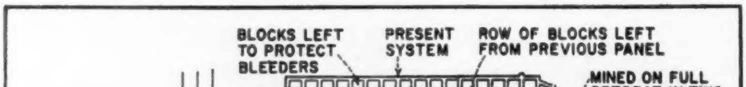
KEEPING EQUIPMENT MOVES DOWN was a major objective in this mining plan for thick coal and ripper-type machines with shuttle-car service. Strict adherence to driving sequence limits equipment moves. Pillars are removed one at a time by 18-ft lifts leaving 10-ft fenders. Bolting units are mounted on the miners. Average output is 43.6 tons of clean coal per faceman.



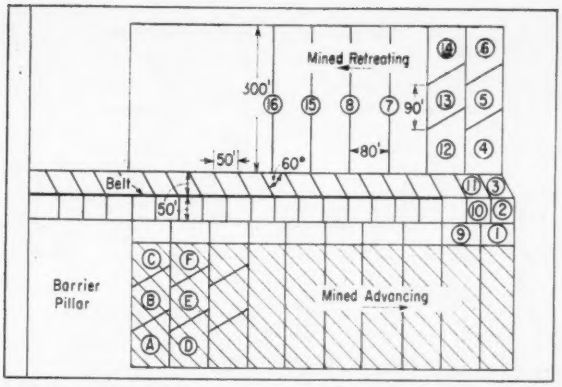
ANGLE CROSSCUTS and angle pillar extraction feature this plan for one-side retreat, boring or ripper machines. Rooms are driven one at a time and pillars are mined immediately.

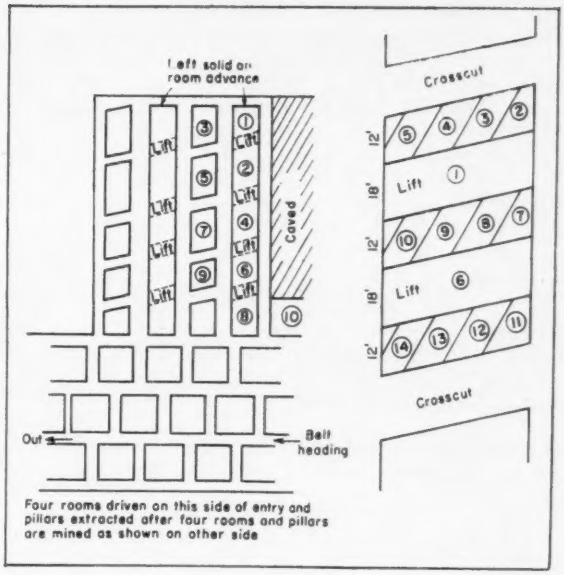


ANGLE DEVELOPMENT with rooms on only one side of the panel features this retreat-mining plan for boring-type miners in medium-thickness coal. The miner changes from one place to the next of two each time it reaches a crosscut. Thin pillars are mined open-ended when a room is completed.

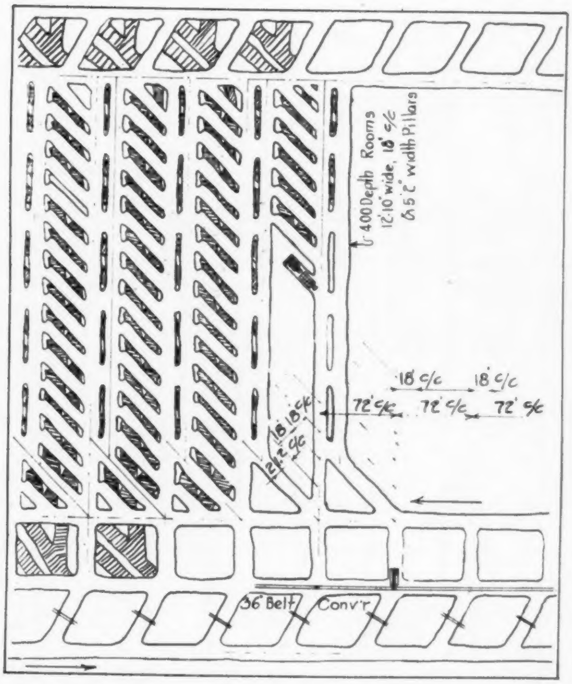


ADVANCE ON ONE SIDE OF THE PANEL and retreat on the other features this plan designed for a minimum of open territory. Two rooms are always kept open ahead of the advancing pillar line by driving a new place as soon as each line of pillars is completed.

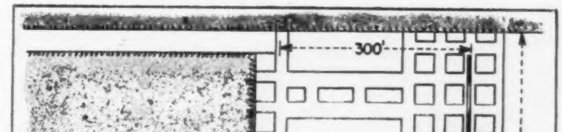




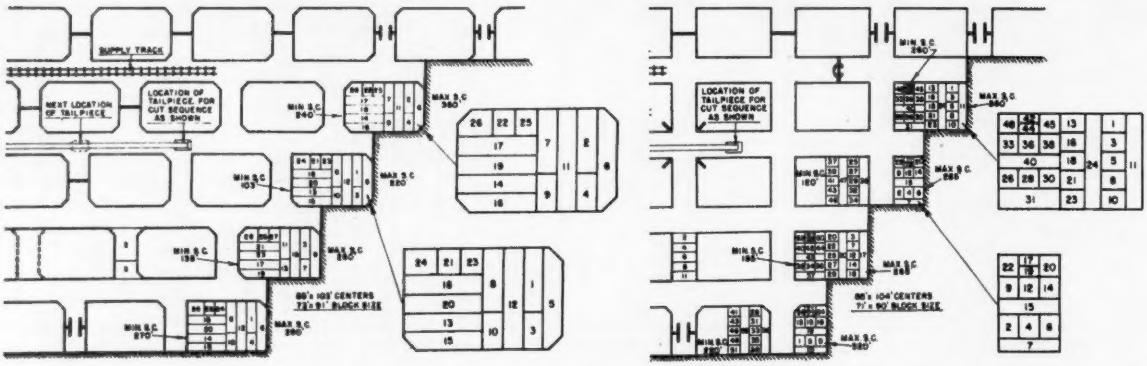
ANGLE CROSSCUTS feature these two plans, one for advance on one side and retreat on the other, and the other for retreat by alternating from side to side four-room groups. Letters and numbers show sequence of development and pillar removal.



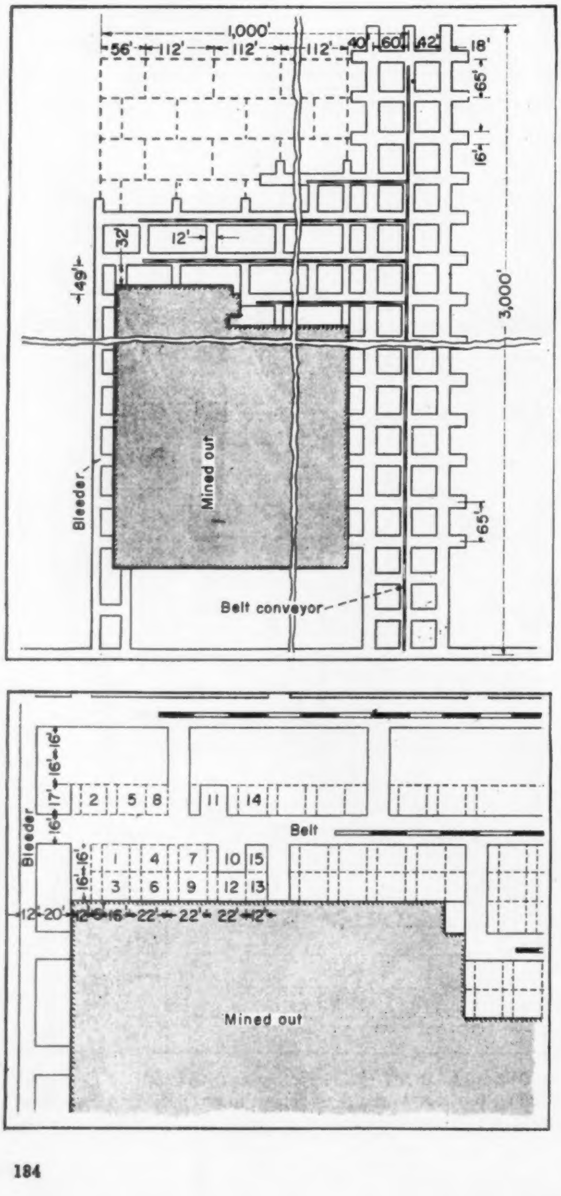
TWIN-ROOM THICK-PILLAR PLAN for boring-type machines is distinguished by angle extraction of the big pillars, with final recovery of the small fenders by pocketing.

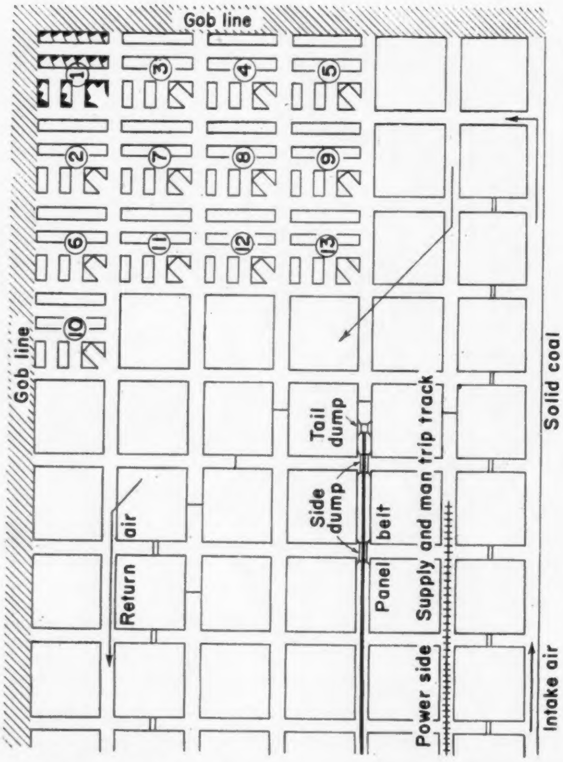


ANGLE-PILLARING PLAN for boring-type miners in 40-in coal. The first two rooms are driven abreast to establish ventilation. Then rooms are driven and pillars are mined on the angle as shown.



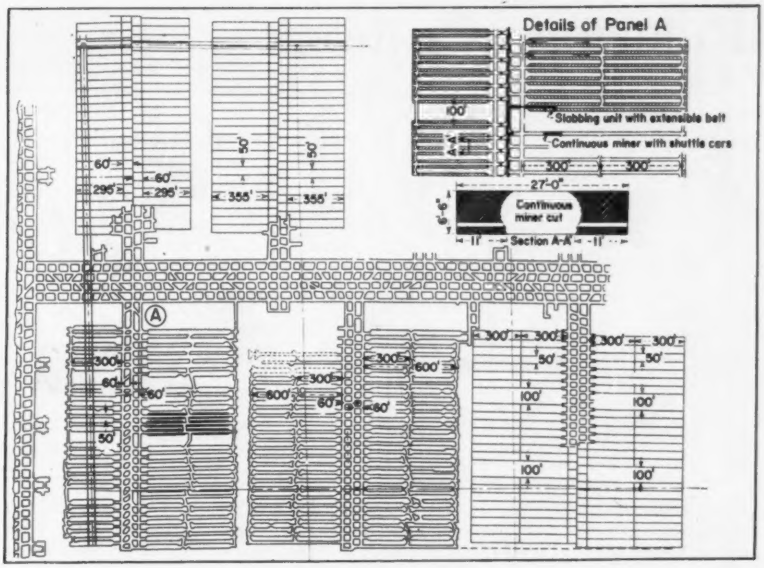
SLICING PLANS FOR THICK COAL, boring or ripper-type machines, involve angle lines on final retreat with two machines working and one spare, leaving bleeder on one side for the next slice. Corners are cut on pillars where boring units are employed. The layouts keep shuttle-car hauls to the bare minimum.

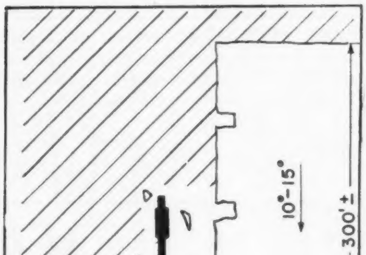




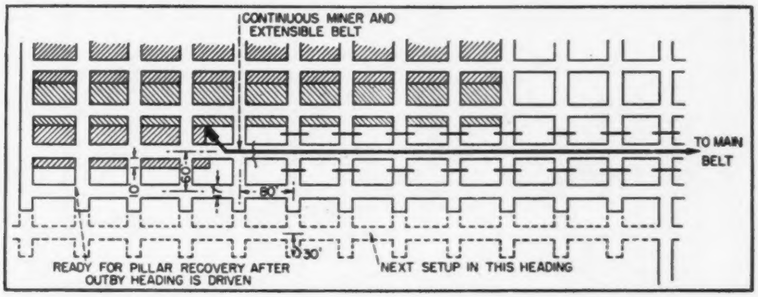
INDIVIDUAL PILLAR RECOVERY on a flat line features this slicing plan for a boring machine with shuttle cars.

RIPPER-MACHINE PLAN for 66-in coal, sections 2,000 ft wide and 3,000 ft deep, mined advance and retreat. Alternate right- and left-hand pillar extraction is practiced, with pockets driven as in the view below to complete recovery. The miners discharge to extensible belts equipped with bridge conveyor. Coal recovery is about 90%, and good pillar falls are secured.

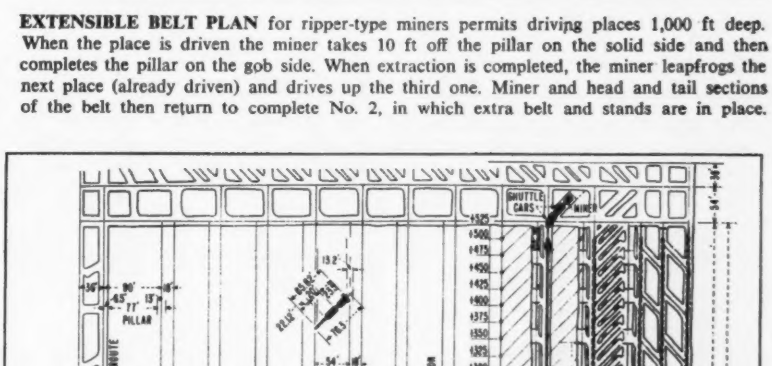




PITCH PLAN for ripper-type machines in 12- to 15-deg work. Blind crosscuts are used for supply storage. Conveyors bring coal down to cars on the gangway. The counter is used for miner travel.

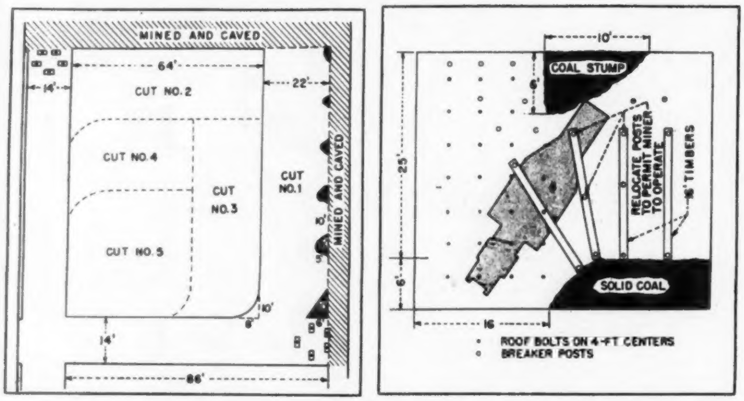


EXTENSIBLE BELT PLAN for ripper-type miners permits driving places 1,000 ft deep. When the place is driven the miner takes 10 ft off the pillar on the solid side and then completes the pillar on the gob side. When extraction is completed, the miner leapfrogs the next place (already driven) and drives up the third one. Miner and head and tail sections of the belt then return to complete No. 2, in which extra belt and stands are in place.

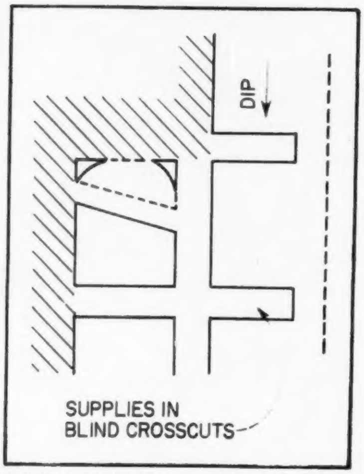


MINING WITH BORING-TYPE UNIT and rope-type belt in 525-ft rooms, thick coal. Pairs of rooms are driven on short centers and pillars between pairs are mined by angle lifts. Chain pillars are recovered with two shuttle cars.

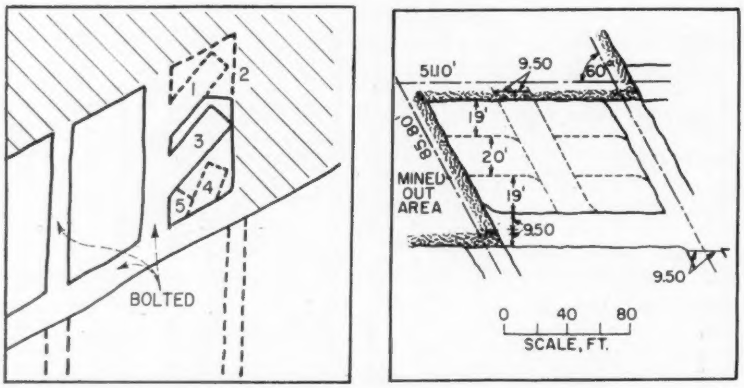
Pillaring Planbook



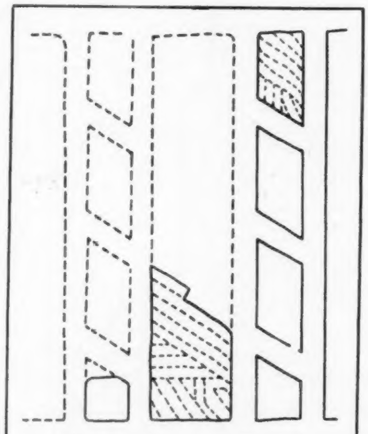
OPEN-ENDING WITH SMALL COAL STUMPS for additional support and protection of the lift across the pillar. The stumps supplement roof bolts and crossbars placed as in the right-hand diagram. Ripping-type machines are employed for the mining operation in thick coal with a drawslate top.



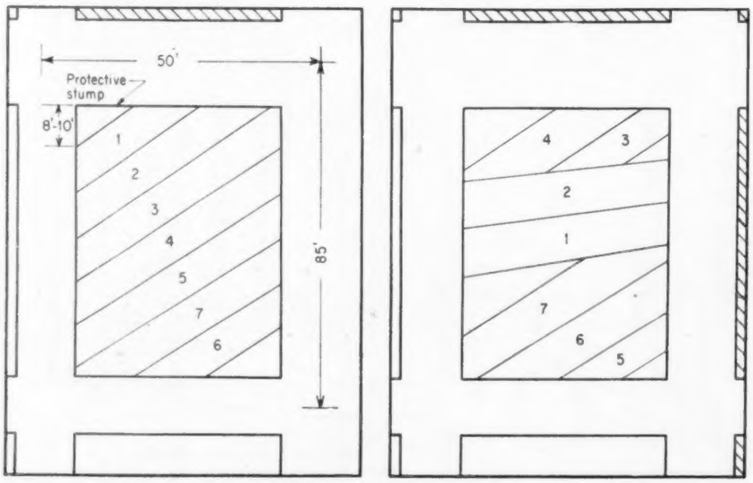
SLANT POCKET is employed in pitch-mining plan with ripper-type machines. Final extraction involves splitting wing on the upper side. Inclination is 12 to 15 deg.



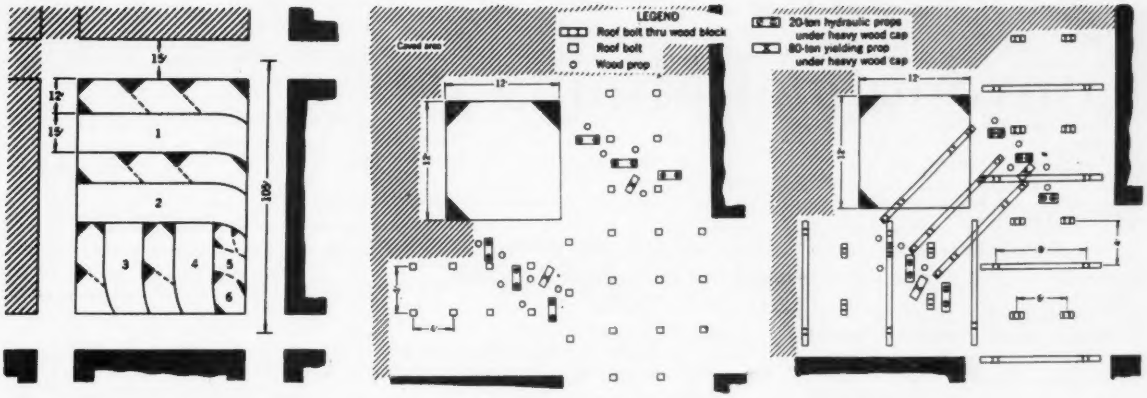
SPLITTING PLANS FOR DIAMOND-SHAPED BLOCKS. Left view shows 60x70-ft blocks, 4- to 6-ft coal, firm shale top, boring-type miners. Fast extraction permits recovering two halves with posts only. Right view, semirigid machines, shows splitting on shorter axis recovering halves open-ended. Square blocks also can be mined with similar plans.



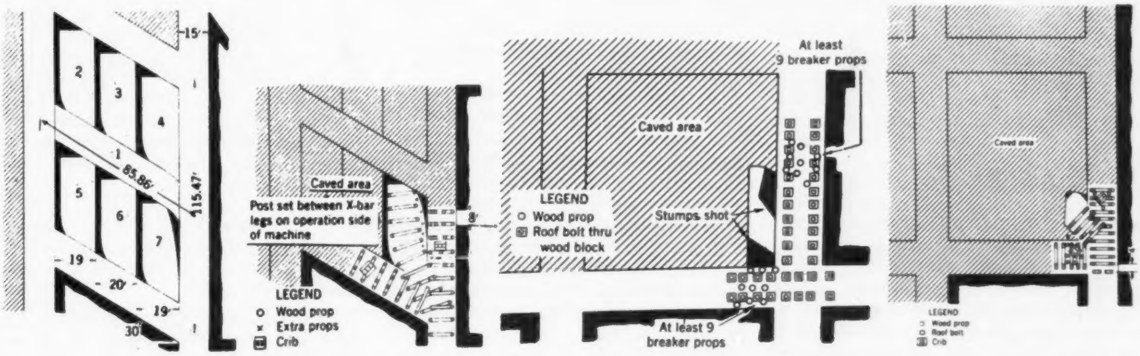
ANGLE OPEN-ENDING combined with 90-deg development. Top is medium hard and places are driven 16 ft wide on 50-ft centers with boring-type miner. Solid pillars between pairs of rooms provide much of the tonnage. Angling favors the boring-type machines.



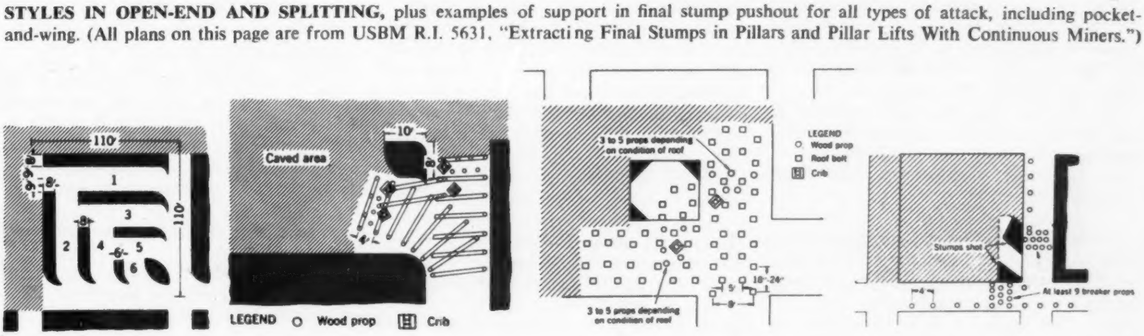
TWO ANGLE-LIFT PLANS for pillar extraction with boring-type units. The plan at the right is employed when caving follows closely on mining.

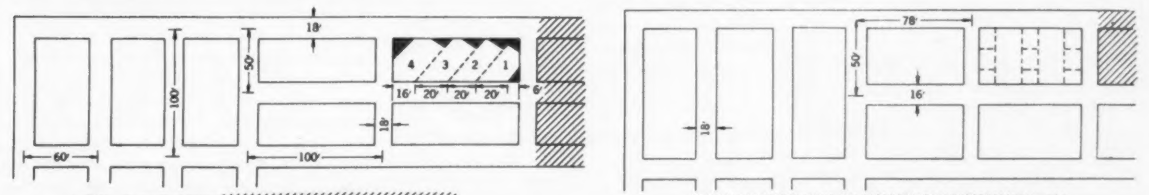


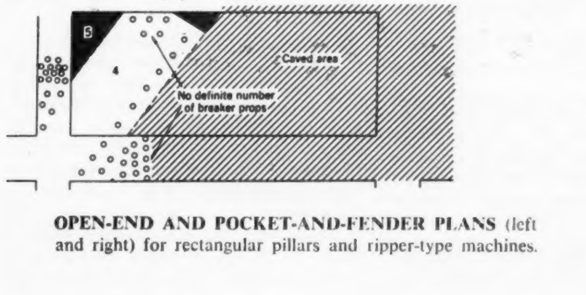
POCKET-AND-WING RECOVERY PLAN—hydraulic props for breakers and yielding steel props in place of cribs. In one plan, final pushout is done with crossbars; in the other, bolts only.

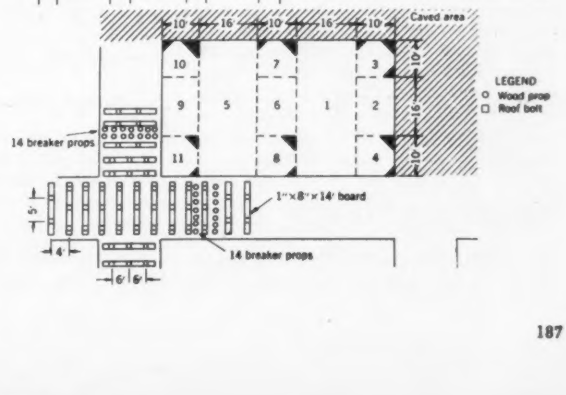


STYLES IN OPEN-END AND SPLITTING, plus examples of support in final stump pushout for all types of attack, including pocket-and-wing. (All plans on this page are from USBM R.I. 5631, "Extracting Final Stumps in Pillars and Pillar Lifts With Continuous Miners.")









OPEN-END AND POCKET-AND-FENDER PLANS (left and right) for rectangular pillars and ripper-type machines.

Conventional Mining

Since 1955

Number of conventional units (loader, conveyor, etc) down from 6,145 in 1955 to around 4,000 in 1960, but total output from such units still is substantial (over 160,000,000 in 1960).

Major gains scored by "punch" or contour mining.

Ahead to 1965

Still further decline in number of conventional units and in tonnage they account for, but a considerable number still will be in service (for reasons, see section on "Continuous Mining"). Higher unit capacities and wider use of special units by the small "truck" mines will contribute to keeping usage up.

Equipment Selection

MOBILE EQUIPMENT, since it is inherently higher in unit capacity and thus more economical of labor, ranks first in choice among available types of loading units. Loaders now are available for operation in coal as thin as 3 ft or slightly less. Matching auxiliaries include the articulated shuttle car as well as the extensible belt and other conveyor systems, all tending to further increase the productivity of the face unit. Very-soft bottom is one of the new possible bars to the use of mobile equipment.

At the other end of the scale loading machines with extra-high capacity, and with auxiliaries designed for the job, have been made available for mining up to 15 ft or more in coal height.

CONVEYORS—Under 36 in and almost certainly under 30 in at the present time, practicable mechanical devices are conveyors and scrapers, the former being preferred. Self-loading heads on the shaking types of conveyors convert them into true loading units.

PITCHING COAL—Conventional conveyor and mobile equipment can be used with a high degree of efficiency up to approximately 8 to 20 deg. At 10 deg or less there is only a slight difference in results, if any. Where haulage is concerned, the breaking point where conveyors usually must be substituted for rail cars or shuttle cars usually is around 5 deg. However, rubber-tired equipment has been used in crosspitch rooms or chambers to around 12 deg. The maximum pitch on which mobile machines may be employed is yet to be determined though up to 18 to 20 deg has been achieved.

Conveyor Mining

CONVEYORS normally are used in groups of two to four, although the variations are almost infinite. The benefits of grouping are those usual with concentration. Single conveyors are found mostly in pitching coal, and in second or third mining of anthracite. And whether single or multiple, in rooms or in entries, conveyors usually discharge either to a panel belt or to a gathering or cross conveyor concentrating the output at a single car-loading point.

Without a flexible joint or a face unit, practicable room width with hand loading usually is 16 to 18 ft. With face units, rooms can be driven 50 ft, 60 ft or more in width where roof and other conditions are favorable. Wider faces ease the problem of arranging the cycle so that loading proceeds with minimum interference and maximum efficiency.

With shaker conveyors, swivels make it possible to swing the face end rather readily provided jacks and posts do not interfere. Thus, within limits, it is possible to widen the place without going to face units or turning the trough. At the same time it is possible to keep the face end of the conveyor in the most favorable position for hand loading. Adding a duckbill or sawbill makes the shaker conveyor self-loading. Power swing and power advance and retract also are available on duckbills.

CUTTING MOVING TIME—One of the biggest headaches in the use of conveyors of the conventional type is not only extension time but also moving time. Though there are not too many, some methods of saving in moving time do exist.

1. Turning the moving job over to special crews.

2. Using pullers and carriers to eliminate most of the physical effort and much of the time involved in shifts from one place to another.

3. Using mobile drive sections. These mobile sections, mounted on crawlers, have made it possible to move an entire room unit completely in as little as 1½ hr.

Certain mining systems help in cutting down on charges for moving conveyor parts and such materials as crossbars and the like. If only one place is worked at a time, as an example, blind crosscuts may be driven toward the next place, and pans, chain and materials may be stored in them for pickup as the new place comes up to the crosscuts. Or, the conveyor line may be left intact in the old place to permit pans to be taken off as needed and moved through the crosscuts.

Special mining plans designed to reduce moving time include the "continuous-room" setup shown in the Planbook later in this feature. One place, it will be noted, serves as a beltway with a cross unit bringing the coal over from the others.

"Panning up," or conveyor extension, when done section by section, interrupts face operations and requires both time and labor. The bridge conveyor is one method of reducing the number of interruptions and the time required. Now, bridge conveyors are supplemented by bridge carriers, mobile conveyors and extensible belts to eliminate all panning between crosscuts, and most of the usual moving operations.

CONVEYOR PLANS—The plans adopted for conveyor mining are as numerous as the variations in equipment units, but the most-used ones are two:

1. Driving the room entry up the full distance and then working rooms on one or both sides on the retreat. If the mining is done on both sides of the panel, one equipment unit may alternate, or matching units may be used on both sides.

2. Developing the room entry and at the same time working rooms on one side of the advance, then completing the panel by retreat on the opposite side, is another common conveyor system. This normally results in a more-even output over the life of the section, and also keeps all working sections on the fresh-air side of the panel ventilating system.

Where the coal is under 3 or 3½ ft and the top permits, many operators prefer to reduce pillars to a minimum and leave them, some arguing that the value of the coal left is less than the cost of the support that would have to be put in to recover it. In at least one instance part of the pillar is pocketed out and the remainder left to protect the next pocket, eventually crushing with subsidence of the top. Where pillars are taken, usual practice is to widen to one side only, putting the conveyor along the straight rib where it is close to the pillars to be removed.

SUPPLYING CONVEYOR UNITS—Supply-handling equipment includes wheeled dollies operating in pan lines, and small hand or powered winches to pull timber and other heavy materials up to the face. In crosspitch rooms, a plank roadway on which a wheeled dolly runs may be built to deliver materials from a hoist in the slope or chute opening.

The false pan line is a simple and effective alternative in flat or mildly pitching coal. Until the halfway point of the place is reach-

ed, a false line is built alongside the regular line by pulling it forward and attaching a section each time the regular conveyor is extended. Each new false pan is loaded with enough supplies to take care of that much advance of the face, and the line is pulled up by the cutter so that the inby pan can be unloaded and added to the regular line. When the last section of the false line is pulled up, the room is completed.

SCHEDULING FACE WORK—The usual face crew, whether loading by hand or power, is 3 to 4 men, with as high as 10 to 12 on extra long faces. Average output, in hand loading, is 1 to 3 cuts in the usual rooms. With self-loading equipment, production is increased to 2 to 4 cuts per shift —sometimes more.

Attaining production rates of this magnitude requires a careful study of crew size and operating cycle. For high efficiency, the various elements in the cycle—cutting, drilling, shooting, etc.—must overlap, and must be tightly scheduled to prevent waste motion and time loss. The basic goal is as little interruption in the flow of coal as possible.

Machine Mining

THE BASIC machine-mining unit, meaning here the unit based on a mobile loading machine, is made up of the loader itself, a cutter, a drill and, in most instances, one or two shuttle cars. Additional equipment may include a roof-bolting unit, a rock-dusting machine and a mobile supply truck.

A high degree of flexibility characterizes this unit, and thus it has been applied in practically all types of mining, including semilongwall, in both thick and thin coal and in both flat and lightly pitching seams. Number of working places per unit ranges from a low of two up to 20 or more. The average is 6 to 10. Crews range from 3 to 5 up to 20 to 25 men, with the most common around 8 to 12. Production per unit runs from as low as 100 tons up to as high as 1,500 tons per shift, with 300 to 600 tons as the majority. Tons per faceman ranges from 20 to nearly 100 in a few instances, with 30 to 50 perhaps the most common.

Machine Systems

Because of the flexibility of the loading unit, mining plans range from completely closed panels with no pillar extraction to what might be termed the wide-open system with all openings—entries, rooms and crosscuts—projected on the same centers. This latter, if followed completely, results in dividing the coal into blocks of uniform size, permitting both flexibility in attack and, at the same time, a standardization of extraction methods conducive to both high unit productivity and high tons per man.

Where pillars are removed with machine units, the tendency is to reduce the angle of the pillar line from 45 deg sometimes down to zero or to a completely flat line. Two major advantages result. One is that the span supported on the projecting points or stumps is materially reduced in going from 45 to some smaller angle. On a flat line the span vanishes. And as the span is reduced, the weight of top in the angle requiring support is reduced accordingly.

Whether short lines or stepped lines are feasible is another question in projection. Each case must be studied individually but there are instances of successful operation with very short lines. Also, there are instances of steps of considerable magnitude in lines. But whatever the system, a cardinal rule is getting the coal out clean or making sure that any pillars or stumps that cannot be recovered are shot before they are left.

HAULAGE CONSIDERATIONS—A key factor in efficient machine loading is coal and transportation at all times. An adequate coal supply requires, among other things, an adequate number of places in which to work. The basic rule is that as soon as the machine is finished in one place coal should be ready in the next for loading. Acceptance of this rule means that with conventional room haulage—usually the shuttle car—the minimum number of places usually is four, exclusive of crosscuts. In the past, however, some operators have approached the question from the standpoint of high tons per man from a small crew in two to three places. If tons per man are high enough, they compensate for the fact that fewer tons are secured per dollar of investment in machines. New equipment, on the other hand, removes this objection to a small number of working places. The bridge conveyor is an example, but even with it there should be enough places so that the loader never has to wait for coal.

Shuttle Cars—Though there are many variations, the section layouts for shuttle-car haulage tend to be one or the other of two types:

1. The panel plan with rooms turned both ways and driven in groups of 5 to 7 or more. One reason for the use of this plan is the fact that pillars are not recovered. However, with modifications, pillaring can be done with this plan also.

2. The conventional block or room-and-pillar plan devised for pillar mining, either with short lines for each room section or longer lines advancing continuously from section to section. To facilitate the latter, some block plans, as noted in the Planbook elsewhere in this section, are set up with all openings on the same centers so that pillar lines can be established and advanced without having to shift gears when an entry is crossed.

Track—Inloading directly into mine cars, maximum efficiency involves these steps:

1. As big a mine car as possible to reduce the number of changes per cut.

2. A one-way distance back to the closest changing point of not over 150 ft.

Conveyors—Continuous availability is the major advantage of the conveyor as a haulage unit, but keeping the loader boom over the conveyor was a major difficulty in early installations. One solution was the bridge conveyor, followed by the extensible belt or other special conveyors to reduce the stoppages for extension.

Early bridge-conveyor plans normally were based on two or three places per unit—sometimes four or five. Basic equipment in the unit was two to five room conveyors, two to five bridge conveyors, a cutter and drill in each place, and a crawler-mounted loader, plus mother or cross conveyor, elevator, car-spotting hoist, roof-bolter, rock-duster and so on. The loader moved from place to place, and a mounted cutter sometimes was substituted for the individual shortwalls, alternating with the loader.

In general a good top or one which lends itself to bolting facilitates the use of bridge conveyors by making it easy to establish the necessary travelways.

An early panel setup for bridge conveyors is shown in the Planbook in this section. Coal thickness is 26 to 36 in. The mining plan (*Coal Age*, April, 1957, p 60) is full retreat with pairs of rooms turned right and left off the panel entry. Panel haulage is by belt. Average output was 21 to 22 tons per faceman.

One of the latest plans for loader-bridge conveyor mining (see accompanying diagram; also Development Planbook for entry plan) involves additional bridge and conveyor units with room belt for continuous loading and a minimum of lost time in moving.

PILLARING PLANS—Loading machines can be used in practically any system of mining individual room pillars, including slabbing and splitting. The two most-used plans, however, are open-ending and pocket-and-stump. Examples of these and other plans are shown in the "Continuous Mining" section of this Deep Mining Guidebook.

A variation of open-ending is pocket-and-fender, under which the stump is cut down to a shell only 2 to 3 ft thick. A subvariation is gripping the cutting machine out each time to make a saw-toothed fender and increase recovery slightly. Timbering plans for pillar mining are discussed in the "Roof Support" section.

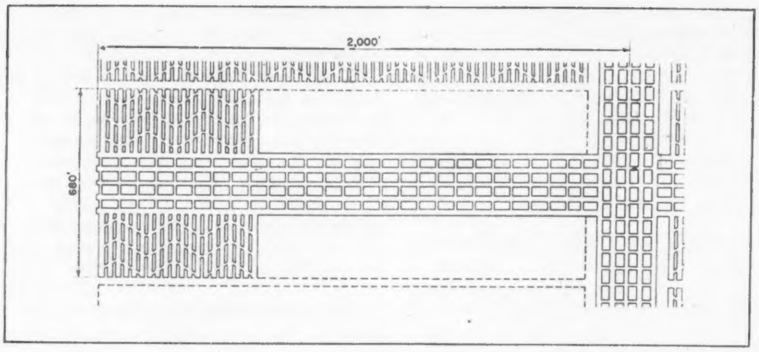
In open-ending, it usually is best to arrange the direction of advance so that the machine operator is on the side away from the coal and protected from sloughing and rib bursts, particularly when heavy weight is the rule and the coal is soft.

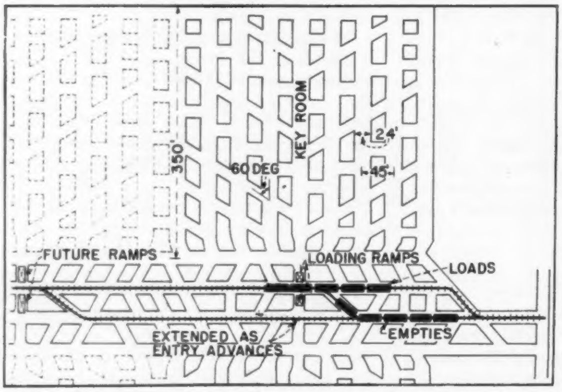
Pitch Mining

LIGHT PITCH—Practically any type of equipment may be used at the face of places driven either up or down light pitches (normally 5 to 18 deg). Usually, however, some form of conveyor is necessary for transportation. With this limitation, all the ordinary panel plans, with or without pillaring, and practically all the conventional face equipment may, as noted, be employed. Usually, particularly as the pitch increases, the practice is to put headings up, down or both—usually up—and rooms across the pitch. Among other things, this permits the use of shuttle cars on pitches up to 10 to 12 deg or perhaps slightly more, the cars discharging to either a lowering or hoisting conveyor relaying the coal to the main-haulage system. Angle crosscuts between places permit

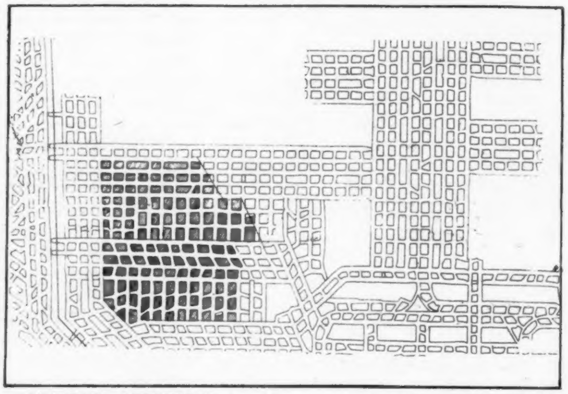
Machine Plans

KEY-ROOM PLAN with shuttle-car haulage in thin coal. The center heading of the panel entry is brushed for track and mine cars. Rooms are worked in groups of five to seven, and the crosscuts are angled from the key room for easy shuttle-car travel.

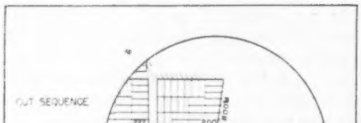




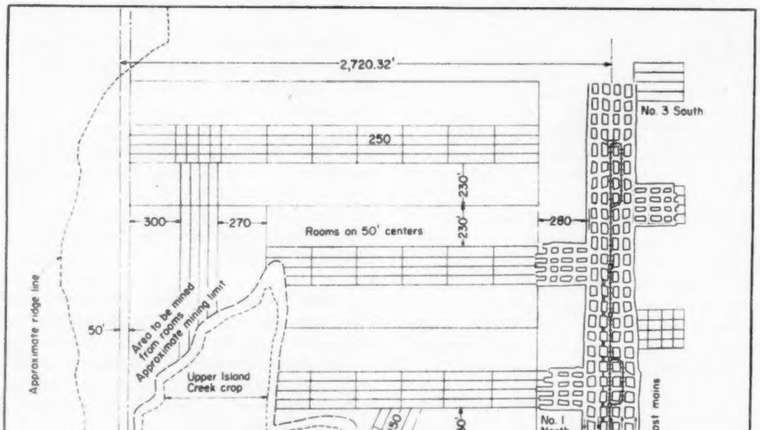
SHUTTLE-CAR PLAN showing double-tracking for mine-car loading, key rooms to loading ramps and angle crosscuts.



BLEEDER OPENINGS in this retreat plan for mobile loading machines are formed by leaving pillars along panel entry.



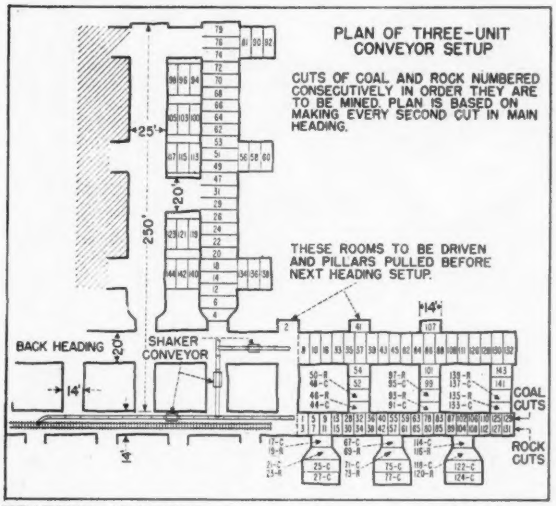
LOOP CIRCUITS simplify rail haulage and keep cars right-end-to in this block plan for shuttle cars. Pillars are open-ended in numbered sequence to provide close control of breakline. New places are developed only as necessary.



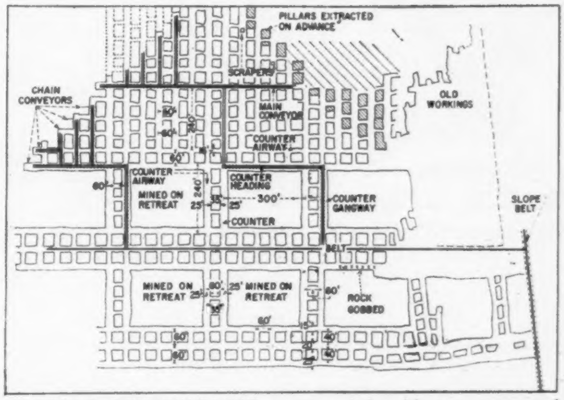
PUNCH MINING, usually on a smaller scale than shown here, involves small compact areas, usually with belts to the outside but with track on occasion. Advance on one side of panels and retreat on the other feature this setup for 3,000,000 tons.

Mechanical-Mining Planbook

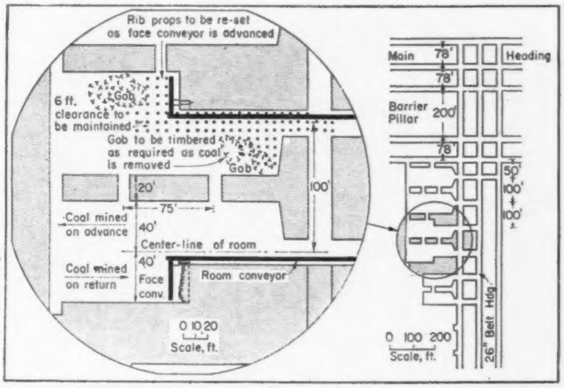
Conveyor Plans



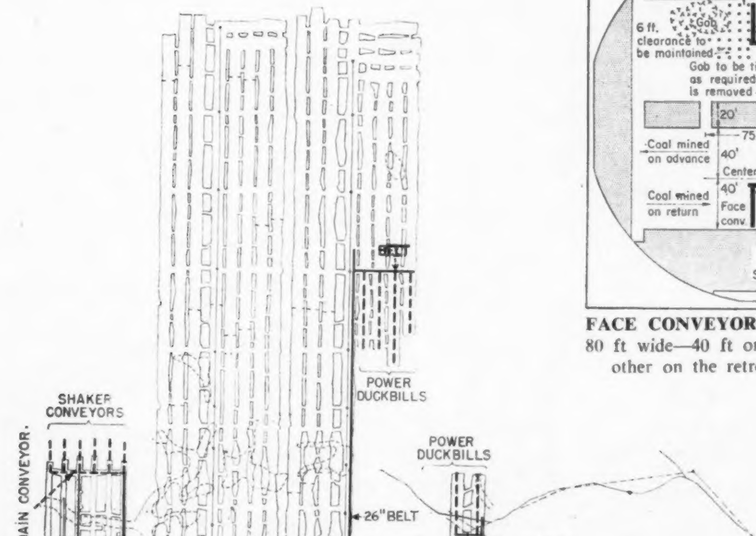
HEADING ADVANCE alternates with room work in this conveyor plan based on mining on one side on the advance and the other on the retreat. Rock is loaded every second cut in haulage headings, where necks are made extra deep.



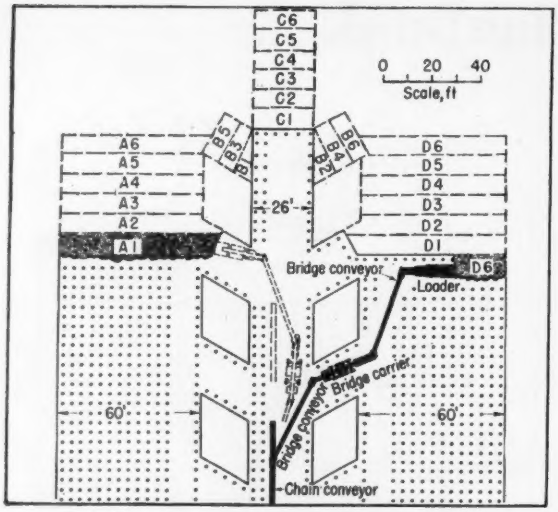
CASCADE DEVELOPMENT up the pitch with two groups of conveyors plus scrapers for recovering pillars. Chutes and lowering conveyors bring the coal down to the main belt in the crosspitch gangway.

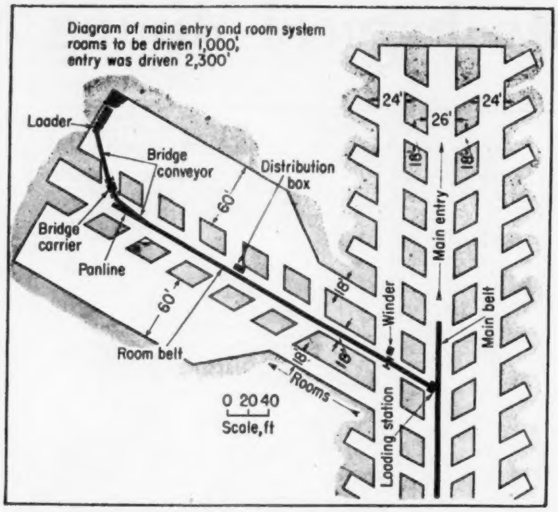


FACE CONVEYORS are employed with shakers to work places 80 ft wide—40 ft on one side on the advance and 40 ft on the other on the retreat. Coal thickness is 32 in with bad top.

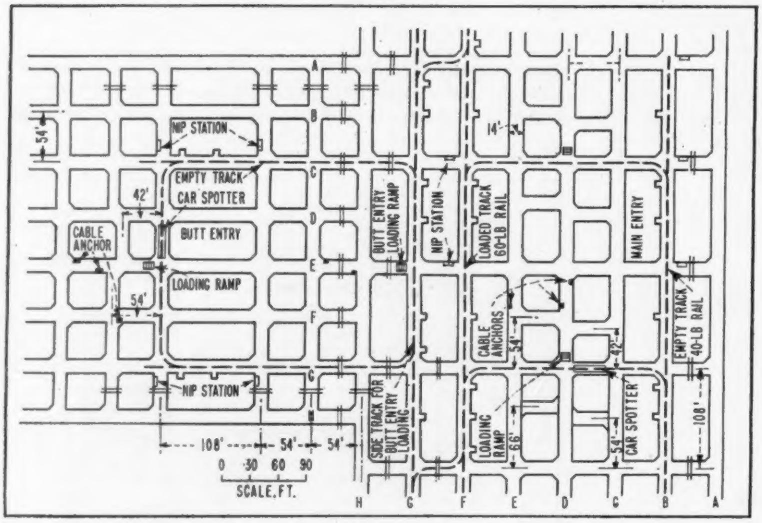


"CONTINUOUS-ROOM" PLAN for conveyor mining permits moving room units straight ahead a minimum distance by using mother and cross belts.

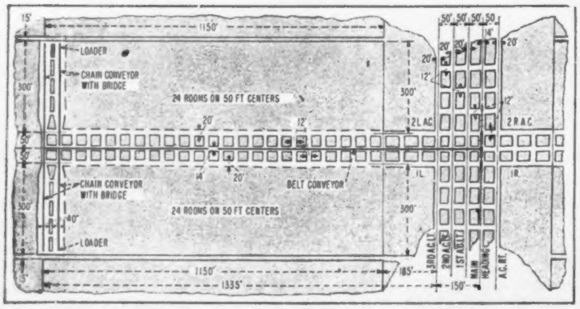




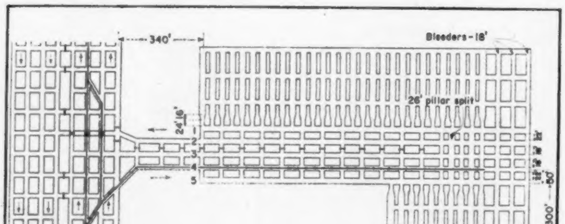
NEW BRIDGE AND BRIDGE-CARRIER EQUIPMENT, plus mobile and extensible conveyors are the key items in this room plan in thin coal. Advance from one crosscut to the next can be made without panning up.



ROOM WORK is eliminated in this plan to permit straightaway advance with eight headings and subsequent mining of entry pillars.



THIN-COAL PLAN is based on using bridge conveyors behind loaders in pairs of places on each side of panel entry. The panel entry (three headings) is first driven to the limit and then the rooms are moved on the retreat.



COMBINATION ADVANCE AND RETREAT PLAN keeps all work on fresh air. Places are normally driven in groups of five and pillars are left. Enlarged pillars at the top of the panel protect bleeder openings.

easier movement of units from place to place in conventional machine loading.

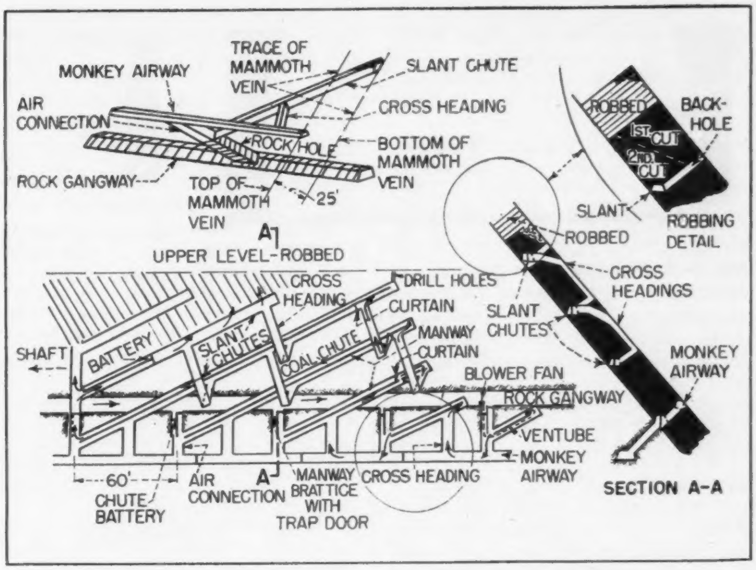
MODERATE PITCH—Galvanized iron kept wet provides perhaps the flattest gradient on which coal will flow of its own accord. The minimum is around 20 deg. At about 25 deg, coal will begin to flow on ordinary iron and, at something around 35 deg, on wood. Below approximately 20 to 22 deg, therefore, it normally is necessary to install conveyors to move coal down the pitch.

Where pitches of this degree prevail, customary practice is to sink belt or rope slopes, turn gangways right or left on a grade rising slightly to facilitate water flow, and then work rooms up the pitch, using hand labor to get the coal to the conveyor or chute. Modifications, however, include a few plans for crosspitch room work. One involves driving a pair of openings up a 40-deg pitch and installing in one a timber track with hoist, a ladder and a chute. Rooms are turned 90 deg across the pitch, and a shaker is installed along the lower rib of each one.

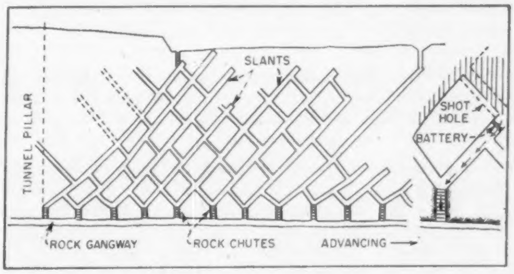
HEAVY PITCH—Attempts to eliminate the high percentage of hand labor necessary in steeply pitching seams have included plans which would cut down the pitch of openings in which men had to work to that on which coal would run on either iron or the natural rock, meaning to a minimum of 35 to 45 deg. The "lattice," "diamond," "slant-chute" and other similar plans differ largely in details—for example, 30-deg openings with sheet iron and without batteries in one "diamond" plan, compared to 45-deg opening, no sheet iron and batteries at intervals in one "slant-chute" system. In both, the openings are first developed to the old gangway above and the pillars are recovered on the retreat back down.

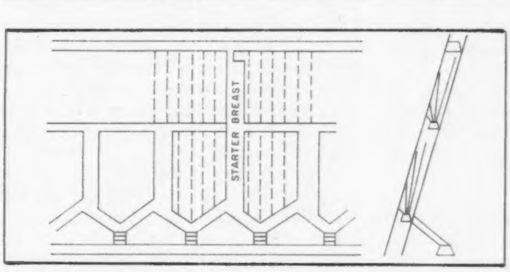
LONGHOLING — Longholing — a fairly recent development—materially reduces the labor required in the preliminaries to production. Variations in longholing methods largely reflect how much preliminary development work is done. In some instances the change is an increase in pillar size, which is then drilled and shot. Or drilling may be done from rock gangways below the vein or, more simply, from sub-breasts and counters (see accompanying plans).

The capital investment required for longhole drilling is relatively small and productivity at the face is increased 50% or more.

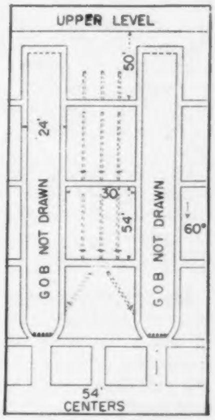


SLANT-CHUTE SYSTEMS (above and below) are examples of plans devised to reduce manual labor and raise efficiency in steep-pitch mining. In line with general practice today, gangways are driven in rock under coal.





LONGHOLE DEVELOPMENT PLANS include this version employing sub-breasts at intervals plus counters for removal of the coal in two lifts.

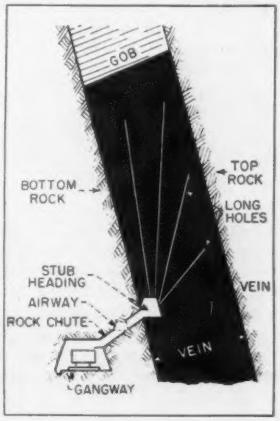


Face Preparation

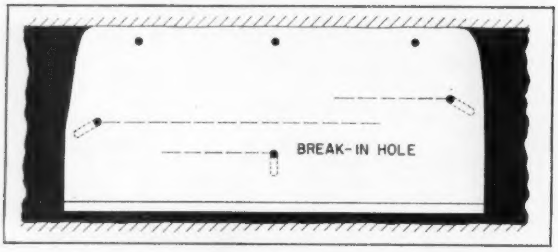
Bits

CARBIDE-INSERT bits for either cutting or drilling normally are well worth their cost. A wide variety of designs are available and thus it is easy to match bits to coal and mining characteristics—and to change when characteristics change. Under some conditions, however, plain quenched bits may be quite satisfactory, with alloy and tipped types filling the gap between carbon and carbide.

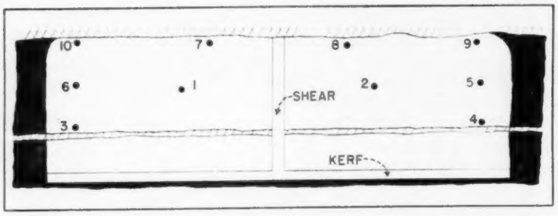
PREVENTING LOSS—It is highly desirable to keep all possible metal out of coal,



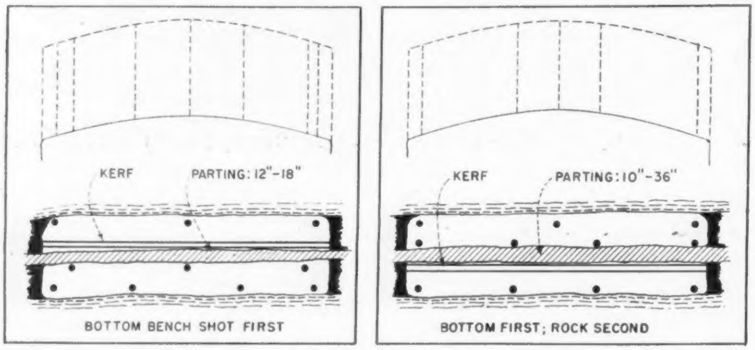
TWO LONGHOLE PLANS show (above) development along usual lines except that pillar size is increased to permit drilling and shooting, and (below) operating in nearly vertical vein with only drill headlines in the coal.



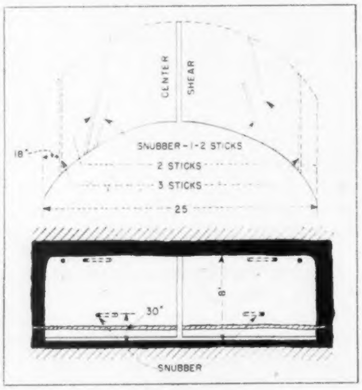
BREAK-IN-HOLE provides additional free face for relieving succeeding holes. In this plan, rib holes are stepped up to break lower part of face in section.



SHORT SNUBBERS break band and roll out front of fall in arc-cut center-sheared place. Shearing and snubbing reduce the number of holes required and also cut explosive requirements.



SHOOTING WITH HEAVY PARTINGS. Plan at left shows cutting above the parting, followed by shooting of the bottom bench first. Plan at right, for still-thicker parting, shows cutting underneath the rock and holes immediately above.



EQUALIZED BURDEN is the goal in this drilling patten, thus achieving good breakage of both coal and impurity band.

which is one reason for care in preventing bit loss or careless discard. Another is bit cost, particularly the carbide type. The rule, therefore, should be an old bit or a thorough accounting before a new bit is issued. Establishment of fixed quantities in the hands of each operator or crew, supplemented by regular inventory, helps keep down losses.

Protection against damage or loss is enhanced by such steps as locked cabinets, and special bit boxes and holders for carrying and storing bits. See accompanying illustrations for examples.

BIT MAINTENANCE—Though there are times in coal mining when the bits just have to take it, one secret of long life and low cost is care in use, including care to remove bits for reconditioning before excessive dullness results in damage, in addition to slowing down the cutting and drilling rate.

Grinding methods can materially affect the cutting qualities of carbide-insert bits, and also the total number of regrinds possible, in turn affecting service life. Manufacturers' recommendations should be the guide. For a step-by-step illustrated description of grinding and reconditioning both cutter and drill bits, see *Coal Age*, July, 1957, p 71.

Cutting

HIGH CAPACITY and greater ease in moving are the major reasons for the increasing use of rubber-mounted cutters, now available for coal as low as 36 in or less. Below that, the shortwall is about the only answer, as well as in coal pitching more than about 10 to 12 deg.

Special equipment for small mines in very thin coal include a shortwall with four rubber-tired wheels which are raised by jacks for cutting and then lowered for tramming.

Hydraulic and other modern controls make the modern shortwall a more-versatile and higher-capacity unit. Bug-dusters can materially reduce labor and normally make it unnecessary to clean the kerf. Otherwise, kerfs should be cleared of cuttings to promote safety in shooting, reduce powder consumption, prevent "hung" cuts and generally improve loadability.

Long bars are a distinct advantage in machine loading, since the more tons per fall the fewer the time-wasting moves the loader has to make. Cutting with a long bar, however, requires greater operator skill and increases the risk of striking undulations in the bottom and top, as well as the risks of fouling and binding.

CUT POSITIONING—Simplicity, ease and custom are behind the preponderance of undercutting, which has the further slight advantage that the fall helps to break up the coal. However, it normally necessitates shooting against the top and thus, where this results in serious deterioration, has led to top cutting. Cutting at other horizons may be done to get into softer zones, but usually is adopted to remove bone or rash. Where the latter is the goal, two or three cuts may be taken—or one regular cut may provide enough loosening and relief so that most of the remaining material can be raked out.

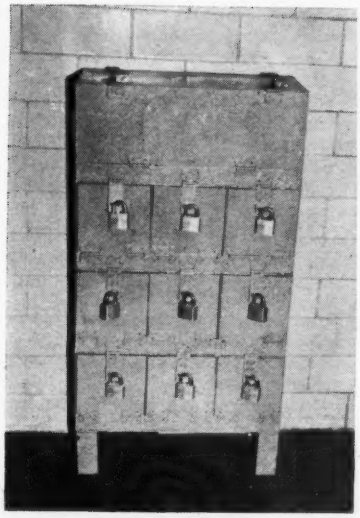
BENCH MINING—Cutting under a middle parting in thicker coal may be done as one step in bench mining, the lower bench being shot up and loaded, followed by dropping and disposing of the parting, and shooting and loading of the top bench. Very infrequently, cutting may be done in rash or soft clay under the seam, or in soft material above, either to keep the kerf out of the coal or to eliminate hazardous or troublesome top material. However, such selective mining is on the decrease and the trend today is toward full-seam extraction, including, in some instances, top stone or drawslate. This system relies on mechanical cleaning on the surface for removal of the impurities, since it normally results in a lower overall cost.

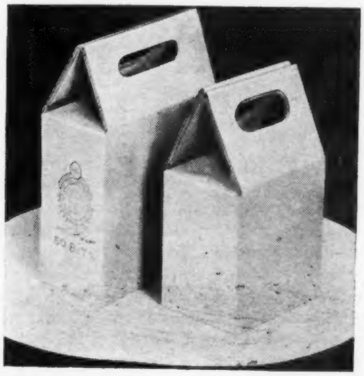
SHEARING—The vertical cut, or shear, provides an additional free face, or faces, and is highly valued by many operators as a means of reducing explosive consumption, raising coarse-coal yield and increasing loadability, even though it does result in more bugdust. In permanent headings, some operators have sheared both ribs to keep them free from shooting shock and thus postpone and reduce falls and sloughing.

Since shearing takes time and, as noted, increases the output of cuttings, shear cuts normally are limited to one—usually at the side in headings or other narrow openings, and between one-third over and the center in rooms.

Drilling

DEPENDING UPON CONDITIONS and personal preference, operators have a wide choice in drilling equipment, including not only pneumatic equipment but also handheld, postmounted and mobile units. The latter may be designed with one or two arms, with the hydraulic auger drive now out





PROTECTION AGAINST DAMAGE OR LOSS is especially necessary with modern cutting and drilling bits. Top photo shows locked cabinet for preventing loss and mishandling. Cabinet has compartment for each section's supply. Middle photo shows wooden bit holders in lunch boxes carrying section numbers for easy handling. At bottom are corrugated-fiber boxes—one of the newer ideas for carrying and storing bits.

front for greater capacity and flexibility. Hydraulic drill positioning frequently can release one man from the crew for other productive work.

Hand-held units driven either by flexible shafts or hydraulic motors are a relatively recent addition to the types of drilling machines available and in some instances have successfully challenged even large mounted units. Light weight, high speed and operation from the cutting machine through either a mechanical or hydraulic takeoff are among the scerets of the machines' success. Where the cutters do not have a hydraulic system, certain operators have found the drill benefits sufficiently large to warrant installation of a special portable hydraulic power unit.

AUGERS—The "conveyor" auger or approximations thereof now has taken over to a considerable extent from the old twisted auger in coal drilling. Advantages include greater rigidity, with consequently less whip, and more resistance to bending. These features are especially valuable with hand-held flexible-shaft or hydraulic drills, where whipping or a bent auger is especially noticeable. Better hole cleaning also is an advantage, particularly where large holes are necessary.

Better cleaning of wet down-pitching holes may be attained by changes in scroll-pitch—usually an increase.

Shooting

A WIDE RANGE of explosives and several breaking devices are available for the operator's choice in coal breaking. The breaking devices include carbon dioxide and air, both basically relying on building up pressure in a tube against a valve or disk which ruptures at a certain limit to release the gas or air and break the coal. Air is the most-used nonexplosive breaking medium, and the practice for some time has been to supply it from central stations on the surface, sometimes supplemented by large portable or semiportable units underground at strategic points throughout the mine.

Breaking with air recently has been facilitated by the development of sequence-discharge equipment permitting the loading of several holes at one time. The tubes are carried on a rubber-tired truck, which also is equipped with a sequencing valve. After placing up to six or so tubes in the holes the operator retires and trips the sequencing valve, which discharges the tubes at invervals of 12 to 15 sec. Normally, all holes in a single row are shot in one group, starting at the bottom. At one property use of the multiple-hole unit permits drilling and breaking up to 450 3-in holes per shift.

As a rule, carbon-dioxide and air breaking require a greater number of holes because the maximum force is less, though some operators get by with no increase and many with only a small rise in number. Any increase or other extra expense normally is more than offset by an increase in coarse-coal yield, or by other benefits, including ability to break coal on shift where all other shooting or breaking is forbidden by law or regulation.

To get the effect of a slower action with powder, some form of "cushion shooting" may be employed if other conditions are favorable. The air space around the charge may be secured by increasing the size of the hole or by placing the charge or stemming to leave an air space ahead or behind. Caution must be exercised to see that cartridges are not separated, thus setting up conditions favoring possible misfires.

HOLE PLACEMENT—Shooting patterns are almost as numerous as coal mines. Normally, the best pattern for any mine can be determined only by careful study and considerable experimentation. One basic principle is that each hole should "relieve" the next. A second is that the burden on each hole should be adjusted to the maximum charge that can be loaded, though this maximum does not have to be the legal maximum. Consequently a common pattern is a row of holes in the top in thin coal, or in the top and middle in thicker coal, with the center hole shot first in the bottom row in two-row faces, and in the top row in one-row faces.

Modifications are numerous. One, as an example, is a row of holes immediately over a slate parting low in the seam to smash it and relieve the regular holes. Another is the snub shot, which may be a full-length hole in or close to the center to knock down the lower part of the cut and open up the face for the subsequent holes. As a variation, the snub hole may be drilled only part way in to break down and roll out the front of the cut. Bottom and snubbing holes may be angled down to get better breakage at the back and more force to kick the coal to the front.

Concentration may be sought for or avoided. As an exmaple, the benefits of drilling a smaller hole may be more than offset by the stringing out resulting from use of smaller cartridges, thus preventing sufficient concentration of force to break the coal properly and economically. On the other hand, concentrating the force at the back of a deep cut in thin coal may result in the charge breaking down to the kerf in the back and leaving the front standing. One remedy is a slower-acting medium in more of the hole.

CHARGING AND FIRING—Stemming always is used with conventional explosives, but normally not with steel-tube blasting devices. However, instead of stemming, safety regulations in some regions require setting safety barriers or deflectors against each hole or the entire face to eliminate flying tubes. In lieu of conventional stemming, blasting plugs may be employed with explosives to save time. Conventional stemming includes the plastic clay dummy made by extrusion and available from extrusion specialists operating in many areas.

Single-shot firing with electric detonators still is the predominant system in the coal mines. However, it has definite disadvantages, one of which is the fact that the shotfirer is constantly exposed to the hazards of loose roof and must work in considerable smoke and dust in connecting to each charge after the first. As a result, there has been a substantial increase in millisecond delay ignition of shots in sequence. There is equal safety in relation to gas and dust, less chance of overbreaking exposing the following charges, less shock to the roof, and much less exposure hazard for the shotfirer.

Effective Roof Control For Less Money

Since 1955 . . .

As a result of continued growth in bolting, 57% of the underground tonnage in 1960 came from under top protected in this manner. Average bolt installation was 3,177,443 per mo, for an average of 4.3 tons per bolt. Reclaimed bolts constituted 7½% of the total installed.

Experimentation and research resulted in initial use of yielding steel jacks and other special forms of support in pillar recovery.

Ahead to 1965 . . .

Fair chance of perfecting of sonic or other methods of determining roof characteristics and especially local weaknesses.

Wider use of yielding jacks and other special supports in face and pillar work.

Reasonable chance of perfection of workable face shield or other movable support providing all-over protection in the face area.

Probable re-engineering of R-C (remote control) miners for use underground, thus drastically reducing need for support in actual production zone.

ROOF SUPPORT is almost always required in coal mining either to protect main openings for the life of the mine or production places from falls that would endanger life and equipment and hamper production. This results from the fact that as openings are made in coal removal, the equilibrium of stresses is upset. The unsupported weight of the top results in a tendency to sag. This sagging continues until failure occurs unless (a) support is provided to prevent such failure or (b) the strength of the rock is such that it can support itself after the sag reaches a certain point.

Support varies with the objective, and also with the character of the material over the coal. For example, temporary protection against drawslate will require one type of support, while another type will be more suitable where both the drawslate and all the overlying material must be held. Still others will be better suited to permanent openings in bad top or caved ground. Weathering as a result of changes in temperature and moisture content of the ventilating air may warrant sealing the top, which is "support" in another guise.

In no instance, however, is it contemplated that the support provided by the original coal bed be replaced by support that will keep the roof in its original place and state after all the coal to be mined is removed. Even "permanent" support means only support until mining is completed. Between the time the coal is first opened up and the final pillars are removed, therefore, a number of roof conditions and roof actions may be encountered—some at every mine and all at some mines.

Timbering

Permanent Timbering

The goal in permanent timbering should be "permanence," meaning that life of the support, within economic limits, should match the expected life of the opening. This is not an absolute rule, however. In ground where movement can be expected for some time until the measures stabilize (longwalling, or driving gangways through previously worked ground, for example), it may be desirable to make the initial timbering job a temporary one, replacing it with final permanent timber when things have settled down.

As an example of "performance" which is not permanent, consider the use of untreated wood with a life of around 3 yr in a haulage heading with a life of 10 yr. Since treated wood normally will last at least 10 yr, it could be considered "permanent," whereas with untreated wood the initial installation would have to be replaced at least once and probably twice, with each replacement more expensive than the original.

Conversely, of course, timber or support life can be excessive—and thus excessively costly—in relation to life of opening. As an extreme example, it would be wasting money to line a 5-yr-life opening with reinforced concrete.

LINING—Support by complete lining is limited to rather special situations in mining. These include: soft sections of top near the outcrop in a permanent drift opening, or other soft or broken areas, as under stream valleys; and permanent long-lived openings on shaft or slope bottoms. Reinforced concrete is the old reliable in heavy-duty linings, and also provides complete sealing. Sealing with some support is provided by sprayed-on sand-cement mixtures, though support is only nominal when, say, the coating is only ¼ to ½ in thick. When applied over wire and in thicknesses up to 1 or 2 in, they provide some holding power in addition to sealing. When used with bolts, support also is realized in addition to sealing. Steel liner plates also provide sealing with a considerable degree of support, and are low in cost and easy to install, using a concrete footwall as a starting point.

GROUTING—Though not strictly lining or coating, grouting has been used to strengthen top in sections of permanent openings under, for example, stream beds where the overburden is thin and the top is rotten. Elimination of water seepage may be a secondary goal. Sometimes it is the major one, with strengthening of the top as a collateral benefit of the grouting operation.

PIERS AND ABUTMENTS—Supports of these types usually are found at pillar points where openings fork, and at other places where considerable resistance to roof movement is necessary. They may be built of concrete, with or without reinforcement, concrete or cinder blocks, brick or masonry.

YIELDING ARCHES AND RINGS—Where weight is substantial, the top is badly broken, and there is a possibility of movement of the ground in which the opening is made, yielding arches or rings may be installed. Some types employ concrete blocks put together on the keystone arch principle. Of the steel types, the latest is the full-round with joints that slip and thus permit diameter to decrease without deformation until equilibrium is re-established.

THREE-PIECE SETS—Probably the widest used of all forms of permanent timbering, the three-piece set—a cross-bar supported on legs at each end—may range from a simple affair put together at the site up to a preframed and largely standardized set designed for heavy duty. Wood is the commonest material. As noted previously, it should be treated where life of opening is expected to exceed about 3 yr. The set also may be made of steel or may consist of wood legs and a steel bar where extra stiffness and resistance to bending are desired. If steel legs are used they should be set on concrete piers or low footwalls for maximum stability, especially in longer-lived places.

Wood is easy to obtain and work, and the three-piece set is both flexible and adaptable. Also, it supplies the required degree of support except under exceptional conditions, in which case special concrete or timber arches are about the only answers. Legs, however, reduce clearance and can be

Roof and How It Acts

THE ROOF SUPPORT PROBLEM in coal mining varies with, among other things, the type of top. Really good top is exceptional, while poor is becoming more common. The material of which the roof is made up is of course a major factor in its strength. Clays are the villain it is now believed, since investigation leads to the tentative conclusion that where they are present and are saturated with water the roof is likely to be weak. Mine roof rock usually is water-saturated.

1. FALLS OF IMMEDIATE TOP—These result, among other reasons, because the top material is inherently weak, such as, drawslate or clod; because of cracks and cleavage planes; because of the presence of kettlebottoms, slips and the like; because of weathering; and as a result of such mining operations as pillaring. Such falls constitute the majority of the "accidental" type, and are the ones causing most of the injuries and fatalities, most of the operating interruption, and most of the cleanup expense.

One question with thin relatively weak roof layers over the coal is, "When to take down and when to leave?" Sometimes the material is so weak and crumbly that the question becomes academic, since there is no practicable way of keeping it up. Roof-bolting with channels, bars and short headers or capboards has made it possible at times to support top that otherwise could not be handled and which, when thick enough, rendered mining doubtful or impossible because of cost, hazard or both.

Depending on coal price, seam thickness and volume to be handled, a certain thickness of top material can be taken with the coal in room and pillar work. However, when this thickness reaches 6 in or more, the chances of economical production are considerably reduced if not completely eliminated. The rule, therefore, is to hold top material in working places, especially since support commonly is necessary for other purposes. There are exceptions, of course, to meet special conditions. In permanent or semipermanent openings, the answer is "Yes and no." One of the conditions, for example, which might lead to a decision to take top is a weak or crumbly drawslate over which is a good slate or sandstone. To save lagging of the slate, cleanup later on or both, the top would be taken to the hard material in installing support.

2. RIB AND FACE FALLS—An alternative form is sloughing which may be defined as minor face and rib falls, with spalling a minor form of sloughing. Rib and face falls also are of the type classed as accidental. Under certain conditions—thick, pitching coal, for example—such falls represent a real hazard. Sprags against the face and posts with plank stringers or lagging along the ribs are among the safeguards.

3. SQUEEZING—In its commonest form, squeezing is the slow increase in weight on pillars or solid coal eventually resulting in such things as crushing of the coal, heaving of the bottom and the driving of pillars into soft floor or top. The cause normally is leaving pillars or other support which, after considerable area is opened up, prove to be inadequate, permitting the top to settle gradually with transfer of the weight to active places and solid coal.

An alternative to squeezing is sudden collapse, which may also occur after a period of squeezing. Like squeezing, sudden collapse is rather infrequent, but it does occur, especially where thin room pillars customarily are left, or where a strong member in the top results in the creation of a large open area without a fall in pillaring. Preventives include ample pillar area and careful attention of getting initial breaks quickly.

4. BURSTS OR BUMPS—These are the sudden, explosion-like failures of coal as a result of internal stress caused by weight. In most instances, conditions conducive to bumping include heavy cover with strong members and especially a strong member close to the coal; a point at which weight and stress tend to concentrate, as the apex of two converging pillar lines, a barrier pillar sticking out into the gob, and so on; and a strong floor. As noted elsewhere in this "Deep-Mining Guidebook," drilling and augering can be used to trigger bumps or unload stress before it becomes too great. The basic line of defense, however, is adjustment of the mining plan to prevent stress buildup. Some suggestions are:

Get all the coal. Clean out timber also, since leaving props and cribs can help set up conditions conducive to bumps.

Mine pillars as fast as possible—at an even rate. The quicker pillars can be mined, the the shorter period of time for stress development.

Orient the pillar line with the natural fracture system of the roof to promote caving in the gob, thus preventing the formation of long roof spans. If long spans cannot be avoided, some means of support should be provided to prevent breaking. Cribs are an example.

Keep development out of abutment or stress areas next to pillar lines and gobs, and develop for new pillars away from rather than toward such areas.

Adjust mining to prevent the formation of points on pillar lines. Keep lines even—no projections into the gob area.

Keep pillars as large as possible to reduce the chance of failure under stress. Uniform size and shape keeps stress even and prevents concentration on certain large or odd-shaped pillars.

Mine individual pillars open-end where possible and keep lifts fairly narrow.

5. INTENTIONAL CAVING—Since caving relieves the remaining coal of weight —at least in substantial measure—and thus eases the job of mining and support where pillars are removed, much of the roof action in mining is intentionally induced. A common goal is a fall each time a lift is taken off a pillar, and this goal is fairly easily reached under conditions ordinarily encountered. Thus, support is provided to (a) break the top at the edge of the new lift and (b), with other support as necessary, to hold the top within the lift and keep it open.

Roof action in intentional caving commonly takes place in two to three stages. The first, or initial, break snaps the roof off at the breaker line. The cave commonly extends 25 to 50 ft up into the main roof. This is followed by a secondary cave, spanning several of the initial caves, and extending up to, say, 150 to 300 ft. If this is not sufficient to take the action to the surface, a third cave and general settlement normally occur. Usually it is of sufficient magnitude to reach the surface unless the cover is exceptionally thick.

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knocked out to cause, in many instances, severe falls, aside from the fact that they themselves represent an expense.

Two-piece sets are an alternative to three-piece under certain conditions—for example in a water-level gangway in pitching coal where one end of the bar is hitched into coal or rock and the other is held on a leg.

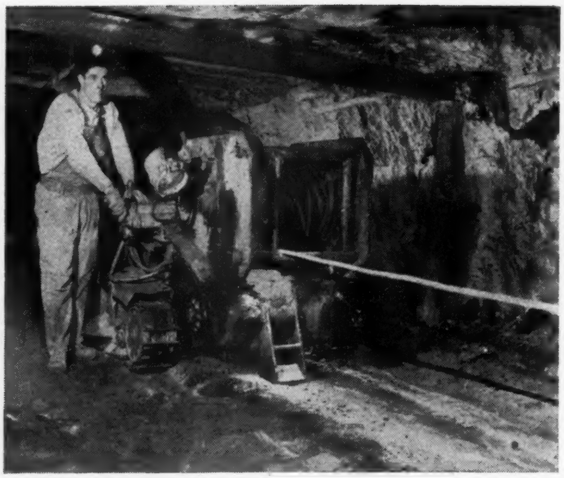
HITCH TIMBERING—To eliminate the leg and its hazards, bars may be installed in hitches either cut or drilled in the rib. Hitch holes may be provided for each individual bar. As an alternative, holes may be drilled some distance apart to accommodate pins. Steel bars are then laid on these pins and the regular bars are placed on these stringers. Properly done, hitch timbering is permanent, especially if treated wood or steel bars are employed, and cost of installation (labor and materials) is much less than installation of a regular three-piece set. Routine maintenance and cleanup are cut to a minimum.

LAGGING—Spalling of top and sloughing of ribs are the reasons for the installation of lagging, which may be small natural round timber or sawed material. In long-lived openings lagging, like main timbers, should be treated. Lagging also provides some support, but its major function is holding loose roof material in place.

SINGLE POSTS—These have a wide use in permanent support, especially in openings where the spacing can be cut down, as in airways, manways and belt headings, or where the roof needs some support but a span of, say, car width can be tolerated. Short headers may be used to increase holding spread in tender top. As with bars and lagging, permanent posts, together with wedges and headers, should be treated.

COAL—Coal itself is widely used as a

MOBILE TIMBERING MACHINES cut cost of adequate face support while facilitating adherence to standard plan.



TIMBER RECOVERY is facilitated by power winches mounted on crawlers or built onto gathering locomotives.

means of protecting and supporting top, though the support is chancy and not too great from the standpoint of resistance to weight. Sealing of the regular top is perhaps coal's major contribution.

Temporary Timbering

Temporary support naturally finds its widest application in the active working areas, including the working face, the room and the room entries. The major objectives are perhaps three:

1. Protecting men. The majority (75%) of roof falls causing fatalities occur in the face area in by the last permanent support, and 95%, says the bureau, are a result of human failure, meaning in turn primarily failure to install proper support.

2. Keeping workings open. The aim here is to preserve access to the face area from which production comes.

3. Holding top during pillar removal. Here, the support should have sufficient strength not only to hold the place open as long as necessary, but also to break the top at the desired point and thus help initiate the caving process.

STANDARD PLANS—The key factor in temporary support, particularly in the critical area within 25 ft of the face, is a plan for minimum support rigidly adhered to and supplemented with additional support where there is any doubt that the minimum is insufficient. The fact that nearly a third of the roof-fall fatalities occur where a timbering plan has been established is reason for emphasizing the need for supplementary support.

FACE-AREA SUPPORT—If coal is to be produced, both machines and men must work in the face area, which also means that timbering must be planned to permit reasonably efficient mining while at the same time providing maximum protection against all the hazards of newly exposed top whose condition is largely unkown.

Among the specific hazards are slips, clay veins, kettlebottoms and the like, aside from general weakness, as in the case of certain drawslates, clods and the like. Also, unless caught, certain roof members will separate and sag, thus requiring more attention than if they had been secured immediately. Swelling or disintegration as a result of moisture are additional difficulties that may crop up in face support.

Safety Posts. The first line of defense in face support is the safety post or safety jack. The latter has the advantage of being easier to install, as well as to move to permit machines to pass. Interference is relatively little with hand-loaded conveyors but increases progressively as mining moves toward mobile machines.

Scaling. An elementary precaution in face work is scaling to remove loose material—usually before or concurrent with the installation of safety jacks. Under some circumstances it is possible to mechanize part or all of the scaling—for example, by mounting a scaling bar on the head of a loading machine and using the machine crawlers to force the bar into the loose material and peel it down (*Coal Age*, August, 1958, p 140).

Crossbars. The crossbar is one logical answer to keeping support close to the face while at the same time keeping down interference. Where the coal is low, cross-barring, especially if weight sags the bars, may result in too-little clearance for mobile equipment. This has resulted, in some mines with poorer top, in conveyors being chosen instead of loaders.

Roof Bolts. Roof bolts also have the advantage, in most instances, of providing good support with maximum headroom. In many instances it is possible, by modifying the face cycle, to install them as the coal is loaded, starting for example, on the right rib as soon as enough coal is loaded to make room. In addition to independent bolting units, many continuous miners now are being equipped with dual bolters so that support may be installed as the machine mines the coal.

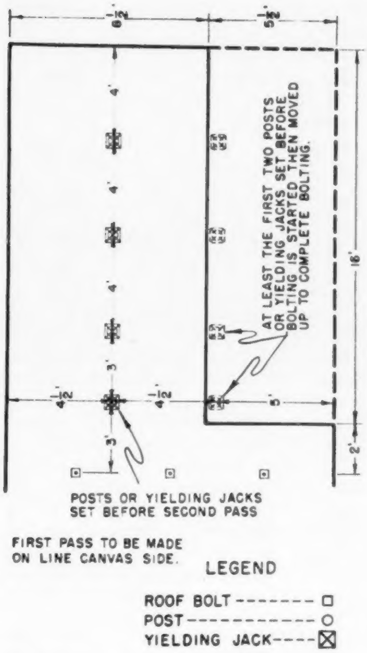
Face Shields. First advocated in *Coal Age* in a discussion of "Timbering for Safety in Mechanical Mining," March, 1945, p 89, the face shield is perhaps the most-logical device for protecting men in the face zone. The original *Coal Age* idea was wire mesh on a frame supported on jacks. As now being developed by the Bureau of Mines, one modification is a frame with bars similar to fore poles on the top which could be moved up as the face advances.

Support Installation. Face support plans are almost infinite in variations but the general routine is to extend posts, crossbars or bolts to the face immediately after loading to protect the cutters, drillers and others engaged in preparing the next fall. Roof jacks may be used to protect machine operators specifically and saddle jacks may be employed under bars to permit movement for cutting with shortwalls. Then, after shooting, the top may be caught by safety posts or jacks (or bolts) as soon as an appreciable area is exposed by loading. Thus, support is provided whenever there is an opportunity for installing it.

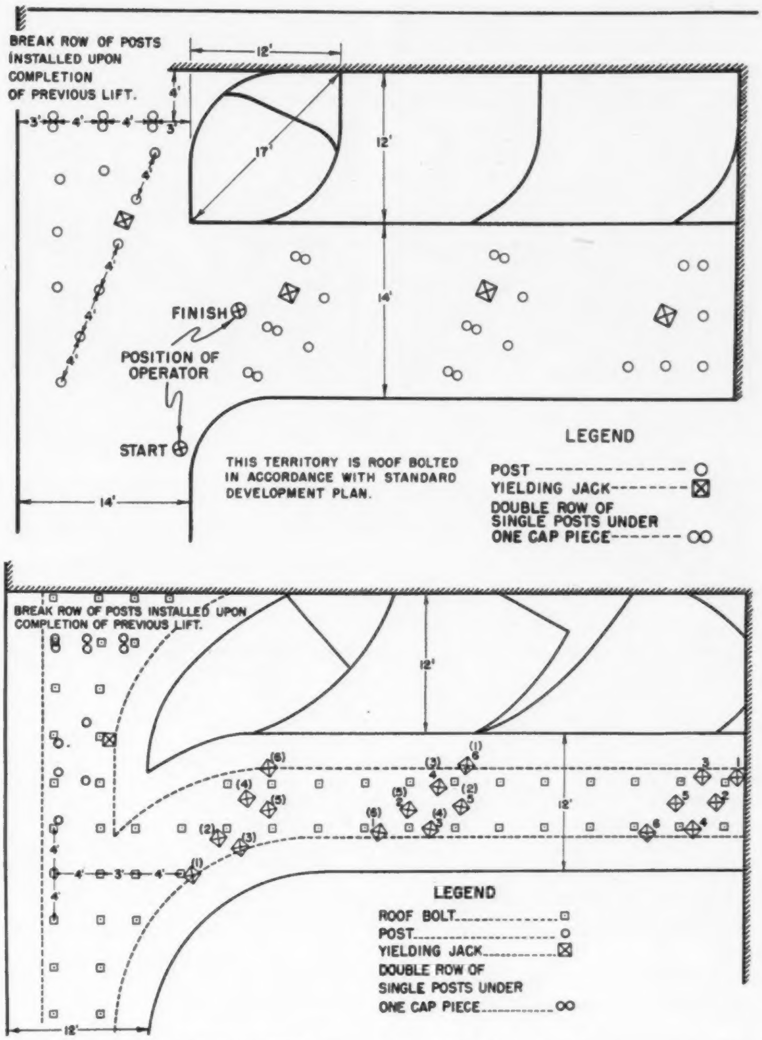
Operator Protection. Protection for loader and miner operators who are relatively far back from the face, commonly is provided by bolts and/or crossbars spotted over the machine and either left in place or moved up. Use of bars of course is dependent upon sufficient height for clearance. Handling bars in the face zone, particularly where they are moved ahead each time a cut is made, is somewhat of a problem, particularly, if metal or heavy wood is needed for strength over the necessary open spans. As a result, a number of operators employ aluminum H-sections which are both stiff and light for high holding power and ease of handling. One mine, as an example, keeps two such bars in each place, moving them ahead when each cut is completed.

In addition to equipment for bolting on the machines, some miners now are equipped with bars on hydraulic jacks for operator protection.

PILLAR SUPPORT—In addition to the regular protection of men, machines and working places, support in pillar sections usually functions as a top-breaker also. Coal itself is a form of support, either as stumps,



TWO-STAGE HEADING ADVANCEMENT with ripper-type machines showing temporary roof support with posts or yielding jacks in center of first pass before starting second.



TWO MINER TIMBERING PLANS incorporating yielding jacks in pillar recovery: top, for ripper machines; bottom, for boring units.

wings, thin straight fenders, or sawtoothed fenders made by gripping or cutting out on the gob side, as examples. Frequently, a part or all of this coal may be recovered and, even if it is not, it represents a support cost considerably less than the conventional timbers or cribs.

Artificial support, as in solid work consists of jacks, posts, bars and bolts used much the same way, plus yielding jacks, cribs and breaker timbers, both the latter primarily to break the top and at the same time protect rooms and pillar places against the riding over of caves.

Heavy weight or other special conditions may warrant special measures in roof support during pillaring operations. At one mine, as an example, the first step in mining a block open-ended is to crib it on the two sides next to the gob, supplementing this with similar cribs on a number of neighboring blocks. Overburden at this operation ranges up to 1,500 ft in thickness and the immediate top is 40 to 80 ft of sandstone.

Getting the final stumps in pillar extraction presents some special problems. Some of the support plans developed for this purpose are shown in the Pillaring Planbook elsewhere in this Mining Guidebook.

Timber Economics

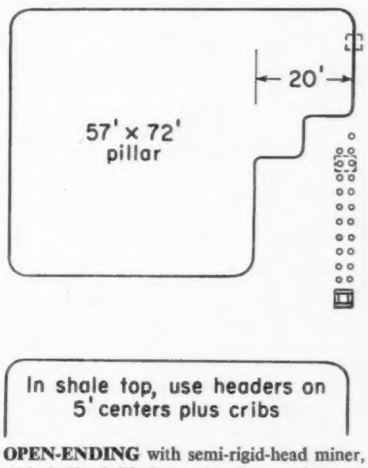
If a cut makes 25 tons and three bolts cost $4.50 to buy and install, the cost is 18c per ton. Therefore, particularly where support recovery is not contemplated, support methods, materials requirements and possible recovery should receive intensive study.

Elimination of fatalities and injuries, and the promotion of efficient mining are, of course, the overriding goals and should not be jeopardized by stinginess in timbering. However, since saving even one bolt per cut amounts to considerable money per ton, a change in the pattern perhaps can achieve this saving and still provide the requisite support and protection. Where bars and other more expensive items are involved, the desirability of close study and economy becomes even greater.

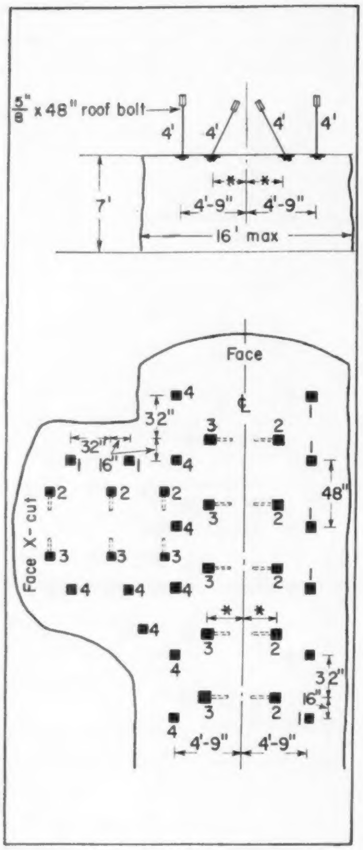
TIMBER INSTALLATION — Even though it may prove impracticable to reduce the number of timbers set—particularly crossbars—substantial economies in setting cost can be achieved by timbering machines.

In addition to mobile units, small hand-operated lifts have been developed for replacement and installation of cross bars in entries and gangways. They are designed for mounting on one end of a flat-bed car or truck.

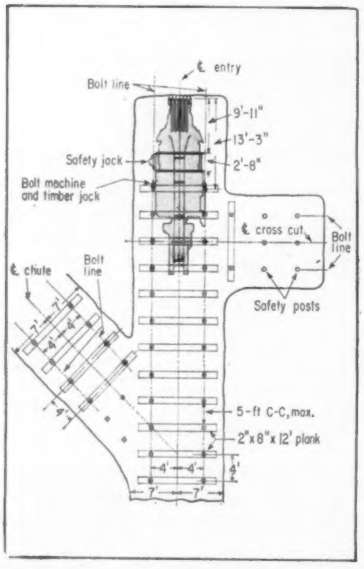
Even without special machines, the timber crew's work can be lightened and its capac-



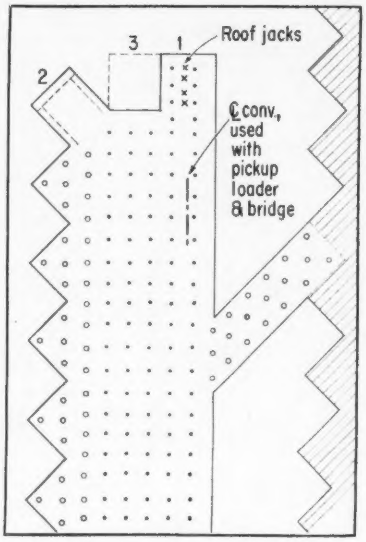
OPEN-ENDING with semi-rigid-head miner, with half of lift kept ahead to make sure support is always present ahead of the operator, and for additional protection. Cribs supplement posts and bars.



VERTICAL AND ANGLED BOLTS are involved in this concurrent plan for ripper machine. Bolts are set not over 4 ft apart.



PLANKS SUPPLEMENT BOLTS in this concurrent plan for drawslate and weak roof members. Safety jacks and bars protect bolters.



ALTERNATE-ADVANCE PLAN employs both bolts and posts for protection.

ity increased by the use of timber jacks to take the manual labor out of raising cross-bars. And in thick coal, where universal cutters are employed, the cutter bar may be pressed into service to lift bars into place.

SALVAGE—The practicability of recovering posts, bars and other timbering material depends on (1) whether it is safe, (2) whether, as with the customary untreated material, decay has left it with little useful life, and (3) the cost of recovery. If these and other questions can be answered affirmatively, recovery can then proceed, but only on the basis that adequate temporary support be installed before the post or bar is removed, or that removal be done from a safe point.

Removal sometimes is synchronized with making falls in pillar mining. Supports may be pulled one by one from a remote point using the old-reliable hand-operated post-puller, or "sylvester." Greater economy and the ultimate in safety is achieved by pulling supports in groups with a power winch, wire line, and chain or chains. Some coal companies, for example, have mounted motor-driven winches on old locomotives to convert them into mechanized pullers, while others have put the winches on crawler-type shortwall trucks.

Even with the best of equipment, recovery is only a fraction of the total support installed, though a sizable one in many instances, with consequent over-all reduction in cost of posts, bars and bolts. In some instances, posts and bars have been reclaimed and reused as many as five times.

Roof-Bolting

BOLTS broke into coal mining as a means of roof support in solid work. They then moved into support in pillaring and also are used to prevent heaving of bottom and the sloughing or caving of coal or rock ribs in shafts, slopes and entries. Bolts, however, are not a universal cure-all for roof troubles, and conventional timber or a mixture of bolts and conventional timber may be better from all angles under certain conditions.

Roof bolts normally function by pinning a number of weak members together to form a strong beam. A somewhat rare function is hanging loose lower members to a strong upper member. In beam-building particularly, the desired result is attained by anchoring the bolt and then screwing a bearing plate up against the top. This it will be recognized, puts the bolt in tension and makes the beam-building action possible. Unless the bolt is tensioned, there is no beam action, and unless tension can be achieved, meaning that an anchoring stratum or horizon must be found, other means of support normally must be employed.

The object in bolting is reinforcing the roof and thus increasing its resistance to sagging and failure. If the roof is good it may be necessary to increase its natural resistance to failure only one-half, as an example, meaning that only a minimum of support is necessary. But as its natural resistance to sagging and failure decreases, the reinforcement factor increases. Thus, for top that is inherently weak, it may be necessary to install support that will multiply its natural resistance to failure as much as 3 to 4 times.

Designing Bolting Systems

For arriving at a proper bolting pattern, the U.S. Bureau of Mines now offers a new plan. In essence, it is based on over-bolting, followed by selective removal of individual bolts (checking everything each time), to arrive at the optimum pattern.

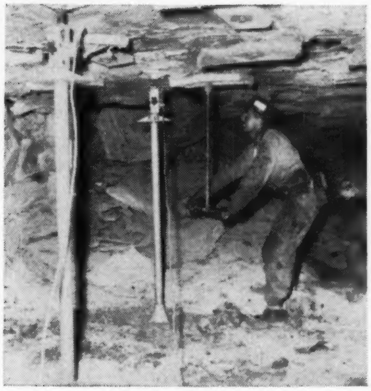
In an earlier system, based on the results of model testing (USBM R.I. 5155, "Design of Bolting Systems," and 5156, "Reinforcing Bedded Mine Roof With Bolts"), the general procedure is based on a roof-bolting design chart.

Results achieved in bolting a particular roof should indicate whether the existing reinforcement factor, as determined from the design chart, is adequate or should be increased by modifying the existing bolting system. In the absence of previous experience the minimum reinforcement factor should be 2; otherwise bolting is not justified. Conversely, if the existing bolting system is judged to be effective, the design chart may be used to develop a system that is less costly.

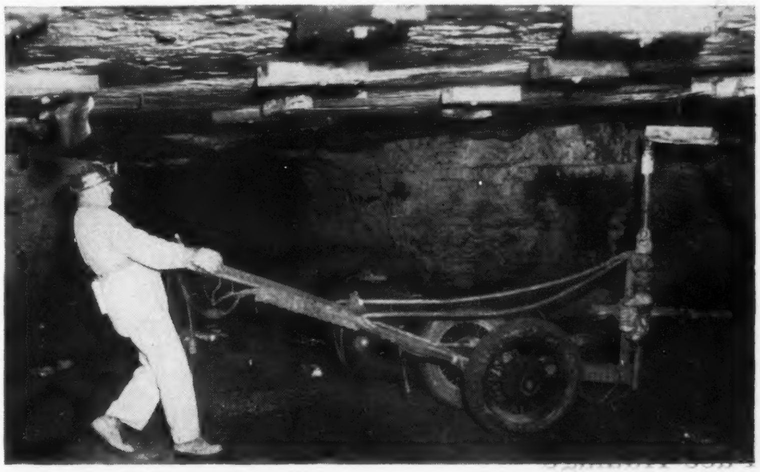
Bolting Patterns

As with timbering, the pattern with bolting must be adjusted not only to conditions at each mine but also to variations within each mine. And since an individual bolt in place seldom costs less than $2, including equipment maintenance and depreciation, etc., saving even one per cut, provided safety is not jeopardized, is a worthwhile economy. By the same token, auxiliary forms of support should be omitted unless they contribute significantly to holding power and safety.

Where bolts are used alone, a check of



BOLT RECOVERY with special jacks designed to be tripped and pulled out by ropes make the job easier, simpler and safer. Recovery stages using the jacks are shown in the three photos above.



MOUNTED WRENCH UNIT permits two men to recover an average of 600 bolts per day.

published descriptions apparently indicates that the majority are placed on 4-ft centers, compared to 4 to 5 ft with crossbars and individual posts.

SUPPLEMENTARY SUPPORT—Even though bolting is one of the best support systems yet devised for holding the immediate top, which is its major function, it is manifest that bolting alone is not the answer to all support problems. One evidence is the occurrence of major roof-fall disasters where bolting patterns were considered satisfactory. True, the number of such falls has not been large, but they have helped focus attention on the following points:

1. The need for auxiliary timbering in many mines to help support the top and equally or more important to give warning of impending collapse.
2. The need for careful checking to keep track of changes in roof conditions so that the support system can be modified to compensate.

In fact, in a few instances, it has been found that conventional timbering is more reliable, easier to install and cheaper, in addition to the support and warning features, plus, in some instances, increased salvage of support material.

Continuous-Miner Plans

The continuous miner presents some tough problems in achieving support without interruption, and these problems are accentuated when conveyors are used for transportation. In return, however, certain miners contribute a benefit in the form of arched or elliptical openings which definitely increase the resistance of the top to sagging and failure.

Unless concurrent bolting is practiced, interruptions in the operation of the miners are almost inevitable if the operator is to be protected at all times by support. Consequently, the usual practice it to advance full-face machines to the point where the operator is under or only slightly beyond the last support, whether it be bolts, posts or bars. This means that the usual advance is 18 to 20 ft, after which the machine is moved back and the newly exposed area is timbered or bolted. An alternate place or places cuts down on the loss of time if the moving distance is not too great.

ALTERNATE ADVANCE—If the machine is not a full-face unit, the practice is to alternate advance from one side to the other. If a full-width cut is taken on each side it sometimes is feasible to bolt one side while the other is being advanced. Adjusting length of advance to bolting time makes is possible to synchronize so that the miner operator is never out from under protected top. If the place is being cut only head width, or width-and-a-half, it usually is necessary to stop and pull back or move to permit bolts or timbers to be installed.

CONCURRENT BOLTING — Bolting units have been devised for installation on all types of miners, whether ripper, semirigid head or boring type. The mounts normally permit angling the drill in or out a maximum of 25 to 30 deg. The usual practice is to swing the unit out on one hole and install the bolt, and swing it in on the next, thus getting two rows on each side of the place, unless only one row on each side will suffice.

The key is sufficient speed in bolting to permit the job to be done before the machine has to move, if it is of the ripper or semirigid type, or until it advances behond the slide or arm range of the unit on boring types. Normally, sufficient time is available to permit a good job of bolting, which can practically eliminate stopping the machine to install supports. The additional production can be as much as 20 to 25% where such bolting is possible. In addition, no member of the crew is exposed to open top with some types of installations, and only the bolters with others. Even then, the bolters are some 12 ft or so back from the face.

CONCURRENT TIMBERING—In addition to bolting, concurrent timbering is being developed to prevent waiting or moving. Posts or posts and bars are installed in conventional fashion in cycle in the usual system. Special systems, however, include hitching on one side and supporting bars on posts on the other. In one instance, a boring-type miner was equipped with cutters making a 6-in slot 18 in deep on the hitch side to accommodate 4x14 H-beams 15½ ft long, using a post and wedge at the opposite end.

Efficiency in Transportation

Since 1955

Ropeframe conveyors become almost standard for underground service and find growing use elsewhere.

Solid-carcass belting achieves major acceptance.

Shuttle cars maintain face-haulage lead in spite of extensible-belt challenge, assisted by the development of the AC and torque-converter types.

Differential-rate feeders widely adopted for transfer from shuttle cars.

Aluminum mine cars first experimental applications.

Automatic trip-loading stations achieve wide acceptance.

New shaft hoists almost all made fully automatic.

Ahead to 1965

Improvements and modifications in extensible belts, and in articulated cascade-type equipment, will accelerate their use.

Cable belts may be expected to get their first foothold in U. S. coal mining.

Diesel locomotives will find increasing use in mainline service after removal of bar against their application.

Aluminum mine cars will challenge steel in considerable numbers.

Crushing and pipeline transportation of coal from the face could become an actuality.

Face Haulage

ALTHOUGH MINE CARS have moved into a minority status in serving face units, some of the lessons learned in attaining maximum efficiency with them apply with equal force to their successors. One lesson is use of the biggest car possible to cut down the number of changes and thus increase loading time. A second is a haulage layout providing at the best a changing point no further back than the next crosscut, and at the worst no farther than 150 to 175 ft back.

Shuttle Cars

As with mine cars, the bigger the shuttle car, within limits set by seam and other conditions, the fewer the changes and consequently the fewer the interruptions in mining and loading at the face. Also, as with mine cars, the closer the changing point, assuming the usual two and sometimes three cars per unit, the higher the efficiency.

New types of cars include the 6-wheeled unit, hinged in the middle to increase capacity in low coal.

Regular AC and torque-converter cars not only offer advantages of simplicity and low operating and maintenance costs, but facilitate AC use.

To compensate in part for the interruptions inherent in hauling with wheeled units, some form of storage may be provided behind the loader or miner. The mine bottom is one form of storage, in turn bringing in the pickup loader.

HAULAGE LIMITS — The maximum length of shuttle-car haul is approximately 500 ft with two cars per face unit. The tendency, however, is to keep the maximum under 400 ft where possible because of excessive loss of miner or loader working time as room depths near their limit.

Separate travelways, where possible, also contribute to speeding up shuttle-car service and thus increasing face output. Under at least some conditions, as shown in accompanying diagrams, it is possible to arrange hauls so that it is never necessary to go through curtains or doors. Other diagrams in this article and in the Continuous Mining Planbook show plans designed to keep hauls to a minimum, and also separate the haulage roads to the maximum extent possible.

TRANSFER TO BELTS — A number of mines apparently encounter little difficulty in side loading belts from shuttle cars, but a greater number limit belt loading to end-on only, with usually a special hopper or a hopper-tailpiece combination to start the coal on its way. Side loading, these operators contend, results in greater spillage and, because the coal comes on at 90 deg, is harder on belts.

In end loading, with auxiliary hoppers, there is an opportunity to install a grizzly to pad the belt with fines before the lumps hit. To load belts, either side or end, a low ramp or an elevating-discharge car is necessary. A saddle-type hopper that can be moved along the conveyor (*Coal Age*, February, 1957, p 108) can help materially when it is necessary to shift side-loading stations often.

Unless belt speed and width are sufficient to move the coal as fast as the shuttle car can discharge, delays are bound to occur. To prevent these, and also to improve belt-loading conditions, a number of steps may be taken. One is to install a two-speed motor with automatic timing control to speed up the belt while the shuttle car is discharging and cut it back automatically afterward.

Transfer conveyors or elevators capable of taking maximum shuttle-car discharge, and at the same time designed to feed to the belt at the proper rate, are used at a number of mines. Conveyors may be of the belt, chain or shaker type, with or without hopper and with or without two-speed controls. Recent units, using either one or two chains, provide differential feeding by employing a constricted discharge and a broad receiving end to accept the coal at full shuttle-car discharge rate. Special transfer units include breakers to reduce maximum lump size.

Incidentally, where a number of elevators or conveyors discharge to a belt, it is possible to interlock to prevent simultaneous operation and over-loading of the belt by the outby unit. One mine uses a skate wheel on a flat spring under the top run of the belt (*Coal Age*, May, 1951, p 83) When the belt is loaded, the spring is depressed to hold in a button locking out all elevators except the one in use. As soon as the belt clears, the button is released to permit another elevator to start automatically.

Another system (*Coal Age*, December, 1958, p 144) also employs a wheel to sense changes in belt loading. Through an arm, solenoid-operated contactors, resistors and a shuttle-car acceleration switch three side-belt operating speeds are automatically provided and overloading of the main belt is prevented.

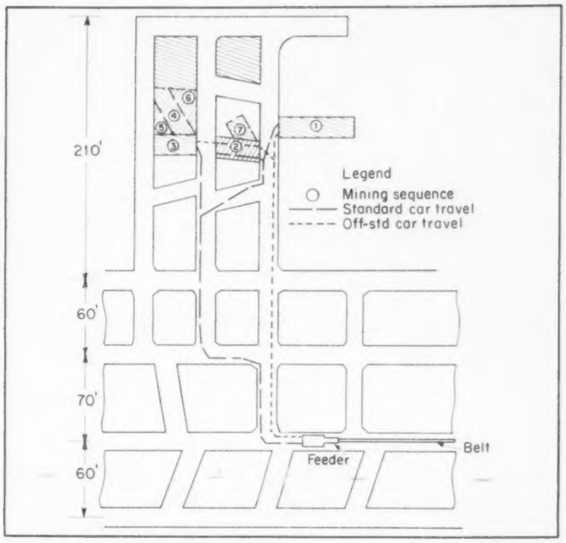
Other suggestions are finger or paddle switches actuated by being struck by coal to prevent an elevator or a crossbelt from pouring coal onto an already loaded main belt.

Conveyors

BRIDGE CONVEYORS—By providing a continuous and continuously functioning connection between loader and room conveyor, and by relieving the operator of all but the responsibility for keeping the machine in coal, the bridge unit has resulted in major increases in tons per man at the face.

Evolution of the bridge unit has included development of the tandem and mobile

DIFFERENTIAL-RATE TRANSFER UNIT, shuttle cars to belt, is equipped in this instance with a breaker over the feeder throat to reduce lumps to the desired top size. Wings form a wide mouth to accept coal at full shuttle-car rate.



PLANNED ROUTES AND MINER MOVES keep shuttle-car travel distance to a minimum, avoid interference and reduce waiting time at the passing point. Differential-rate feeder at the belt tail saves time at this point also.

bridges, the latter being able to advance and retreat under its own power, as well as other types.

One combination of bridge and other units providing up to 150 ft or more of distance between face and room unit consists of a 40-ft bridge unit, a bridge carrier and a second 40-ft bridge, plus a mobile room conveyor 120 ft long. As the latter moves up it pulls out up to 50 ft of extensible belt. Plans showing one of the units in entry driving and room work appear in the "Development" and "Mining" planbooks elsewhere in this Guidebook.

ARTICULATED AND CASCADE CONVEYORS — Development of the continuous miner and accompanying emphasis on development of conveying mediums also has resulted in the design of articulated and cascade conveyors and conveyor systems. One version of the articulated conveyor developed for a boring-type miner consists of a series of interconnected belt conveyors on wheels, each with its own driving and propelling motors (*Coal Age*, January, 1954, p 64).

The cascade system is substantially similar, but has some differences. One is in the fact that the conveyor need not be coupled, though hitches are provided to permit the train to be pulled behind the boring unit in one remote mining system. To avoid inserting and removing conveyors one at a time, the latest idea in remote mining is to store the conveyors in a structure with circular ramps. As the machine goes in it pulls conveyors off, pushing them back up on the way out.

Extensible Conveyors

Development of the bridge unit was the first step in really bringing the conveyor into the picture as a means of serving loading machines and continuous miners. The next step was to design the room conveyor so that it could be easily extended to keep up with the face unit.

Chain-type conveyors of the extensible type are a recent offering (*Coal Age*, May, 1957, p 111).

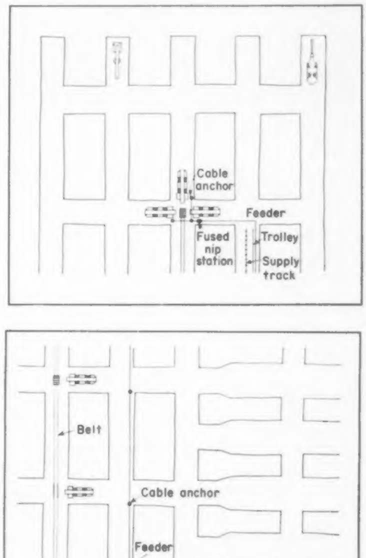
Trip Loading

Track Layouts

The simplest form of track layout for car or trip loading is the tail-track system. The track can merely be extended down the heading, or it can be turned right or left, as shown in an accompanying plan, or it may be turned right or left and then turned back U-fashion in an adjacent heading. The major disadvantage is that trips must come out the same way they go in, meaning increased loss of time unless the changing track is very close.

Sidetrack or loop-track systems (see accompanying plan and also the "Development," "Continuous Mining" and "Mechanical Mining Planbooks") provide access from both ends, and thus permit the quickest-possible trip changes, with no time loss at all if properly set up. The sidetrack may be in the same heading as the main track.

AUTOMATIC LOADING — Complete loading of trips without any operators or attendants whatever already has been achieved in coal mining. Now, the number of such installations is increasing at a fairly rapid pace. Late-type underground stations include facilities for automatically diverting the coal from one car to another, controlling the hoist moving the trip, and starting and stopping the belts. Even cars off the track are provided for.

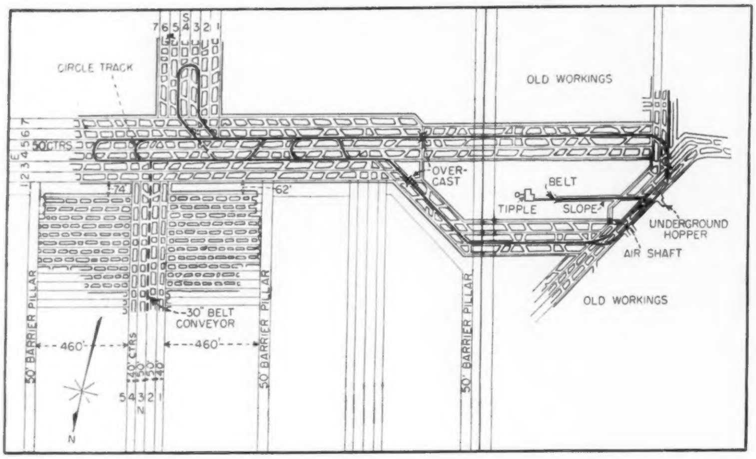


END AND SIDE DISCHARGE for shuttle cars to belts. All cars have their own routes. Three cars can be accommodated.

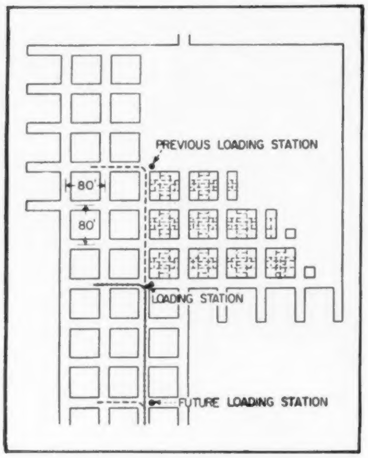
SWITCHING COAL — The problem of switching coal from one car to the next in continuous trip loading can be met in a number of ways. One is the overlapping mine car or articulated trip in which facilities to bridge the gap are built onto the cars.

Where the coal flow is not too great, means of preventing spillage during car change include a simple plate or chute to catch coal during the change.

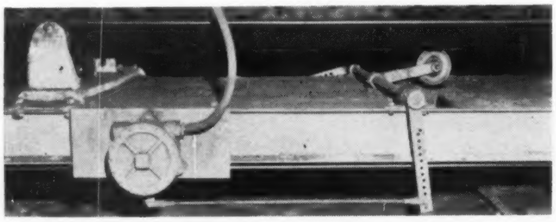
Heavier flows of coal, as off a mother belt, usually require power or some other

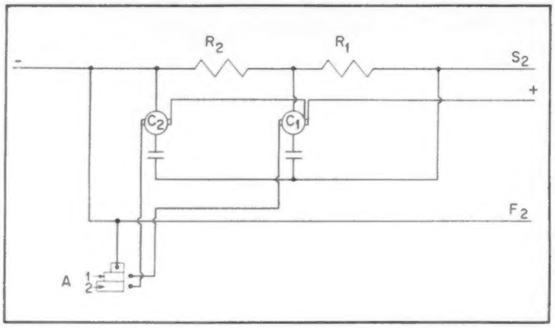


TRIP-LOADING PLAN illustrated above involves circle tracks around the beltheads, permitting locomotives to move trips continuously without storing empties. The loop is completed at the slope bottom.



SIMPLEST TRIP LOADING is tail track, turned 90 deg through crosscut, as shown in this plan.





PREVENTION OF BELT OVERLOADING is accomplished in this system by load-sensing wheel and electric control circuit (*Coal Age*, December, 1958, p 144).

type of equipment for a quick change. Power equipment includes the short reversible conveyor mounted transversely under the head of the main belt. Equipment without power includes a "pants chute" with flop gate to divert the coal stream from one car to the next.

Main Haulage

Rail

ONE-STAGE OR MULTISTAGE? — Main haulage usually is in two stages, relay and main-line, with a few operations dividing it into relay, secondary and main. There is a disposition, however, to question whether multistage operation should be adopted automatically. One-stage operation requires heavy track to the belt head or other loading station, but the extra cost may be much more than offset by decreased haulage labor and maintenance costs.

CARS AND LOCOMOTIVES — Even though cars are less and less taken to the face, where size has an appreciable effect on loading-machine productivity, capacity still is an important factor even in main-line service. One argument for the biggest possible car is that it costs relatively less to buy big cars than small cars. A second is that the big car holds more coal per pound of car weight, and therefore less dead metal has to be dragged around for the same coal.

In the case of locomotives, if one big one can replace two smaller ones, there is an obvious saving in labor. Or two smaller units can be made into a tandem job to get the same saving. In at least one instance also, three small machines were tripled into a single 12-mph unit with spectacular savings.

Aids to safety, efficient operation and low maintenance in car design include:

1. **Automatic couplers.**
2. **Spring draft and buffing gear.**
3. **Antifriction-bearing wheels.** With high speeds and swivel trucks, as in 8-wheel design, wheel metal and treatment becomes a more critical problem. Answers include special mixtures and chilling with cast iron, and cast or forged steel.
4. **Lightweight corrosion-resisting materials.** Newest is aluminum plate, shapes and extrusions for maximum weight reduction. Another form of construction for simplicity and strength with minimum weight is the use of standard structural shapes—for example, channels for sides and ends on low-vein cars.

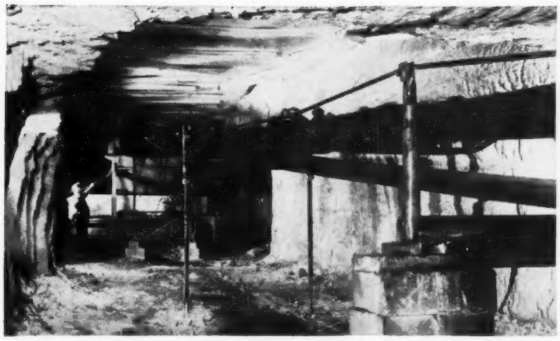
Antifriction bearings also mark the modern locomotive, which, especially in main-line service, tends toward a higher rated speed, usually 12 to 15 mph, with certain types rated up to 35 to 40 mph. Modern electrical controls include provision for dynamic braking where grades warrant.

Except where the haulage system is of the simplest type, the dispatcher is essential for efficiency in haulage. He uses not only the regular telephone but, along with other mine personnel, the carrier-current phone—on locomotives and cages as well as in offices and stationary communication posts throughout the mine. Ready communication with locomotive operators is the great advantage of the carrier-current instrument.

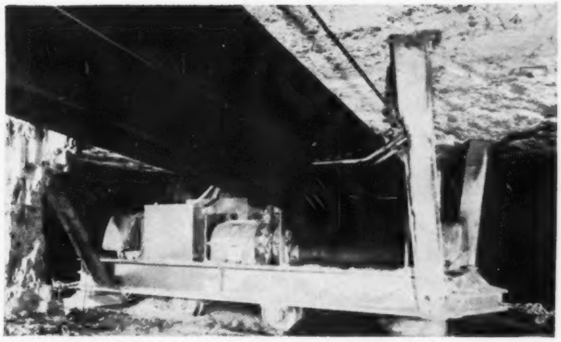
Block signals at times can take over in part or completely in control of haulage, aside from their other major function of preventing interference and collisions. Normally, however, in the control area, they supplement and round out the dispatching program.

Belt Haulage

PORTABLE BELT HEADS—A new development with the ropeframe conveyor is the portable belt head. The drive section, including motor, controller and power-transmission facilities, is mounted as a complete unit on a rail truck. To move it into position, it is trammed to a spot in the first crosscut inby the main line, which means that the drive is 60 to 100 ft from the belt



PORTABLE-HEAD CONVEYOR discharges at left into mine cars where automatic loading controls swing flopgate to prevent spillage between cars. Drive is out of picture at right.



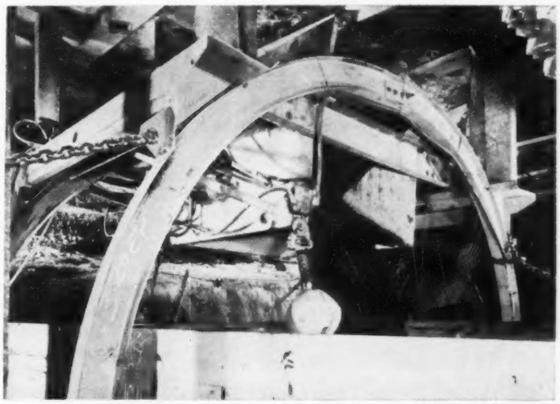
DRIVE UNIT of new belt operates from truck which is anchored in position in tracked crosscut. Unit can be moved in as little elapsed time as 4 manshifts.

discharge. The drive stays on the truck, which is anchored in place while remaining on the rail.

The discharge pulley, together with a flopgate chute, are integral parts of a knockdown arch unit which is set up to straddle the mainline track. The arch, flopgate chute and pulley assembly are hauled to the site on a mine car. The arch then is set up and the two-way chute and pulley mounted in place.

Wire ropes are then attached to the arch and are strung out along the entry, passing over the drive. Two or three adjustable supports are used to hold the rope between the discharge and the drive. The remainder of the conveyor is the standard ropeframe unit.

One move involved shifting the entire 2,000-ft-long unit from one entry to another and setting it up ready for use. Total labor required was less than 4 manshifts. In contrast, the usual requirements for the conventional rope unit is 30 manshifts or more.

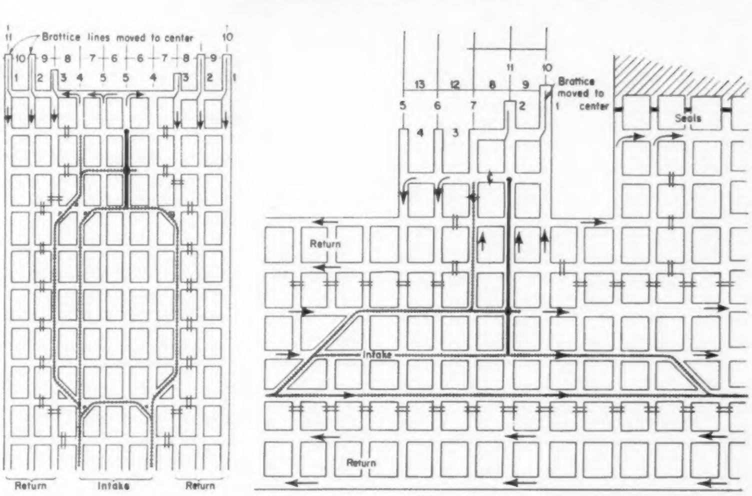


ARCH UNIT, straddling main line track, supports discharge pulley, flopgate chute and other equipment of portable-head conveyor application.

Belt Operation

One secret of efficiency in mainline belt haulage is proper installation according to the recommendations of the conveyor and belt manufacturers. Another is the employment of one man properly trained and equipped to patrol, service and lubricate each 1½ to 2 mi of belt line. A third is proper loading of the belt. Chutes should turn the coal in the direction of the belt, lay down a cushion of fines and, if possible put the coal on the belt at the same speed. In a few high-tonnage systems, short speedup belts are used to turn coal from panel belts and deposit it on the main-line units in the right direction and at the right speed. Thus, the punishment is largely confined to the speedup unit. Big lumps, incidentally, require a wider belt, a heavier carcass and proper covers. Cushion idlers at transfer points are essential in helping protect the belts. Good splicing is a must.

The most effective method of determining motor and/or belt overloading, particularly with panel belts, is reading the motor current with a tongtype or other meter. Stuck idlers, piled up loose coal rubbing on the belt, and belt rubbing against the frame are common causes of motor overloading. Another, in addition to piling on too much coal, is too much belt for the grades.



TRACK AND MINING PLANS for portable-head conveyor show how spur is provided for mounted drive. Plans also illustrate shuttle-car haulage without going through curtains.

FIRE PROTECTION—In addition to the already-accepted methods (*Coal Age*, March, 1958, p 122) the first line of defense against belt fires today is use of fire-resistant cover and impregnating materials. Those employed in belts approved by the USBM are two:

1. Neoprene.
2. Polyvinyl chloride (PVC).

An additional advantage of the fire-resistant belt is elimination of the need for a neutral-air opening or a separate split, thus approximately halving the number of stoppings required in a beltway.

ELECTRICAL PROTECTION — Suggestions for electrical control and protection include:

1. Connecting each drive to the line through a stepped resistance.

Better Track For Better Haulage

GENERALLY ACCEPTED STANDARDS for good mainline track include 70- to 90-lb rail on heavy treated ties laid in crushed slag, gravel or cinder ballast. The importance of treated ties is shown by one study indicating total tie costs for 1 mi of track for 20 yr as follows: treated ties, $10,600; untreated ties, $34,000.

Welding has come sharply to the fore as a means of joining rails, with steel arc the most widely employed. Recently a new type of aluminum joint, featuring extreme simplicity in application, has been making gains, however. Curves should have a radius of 300 to 500 ft and should be superelevated. Turnouts should not be less than Nos. 5 to 8. Trolley wire should be hung at a uniform height above the rail and aligned with it at the proper distance outside. Shoe-type collectors should be used where feasible, especially on heavy-duty locomotives, and the trolley wire should be adequately lubricated at the proper time intervals for low maintenance and efficient current collection.

Throws and switch-position indicators are essential for safe, smooth main-line haulage, while alloy frogs and proper guarding keep down maintenance and reduce derailments. Automatic switch-throwers and remotely actuated derails save labor and promote safety.

DRAINAGE—Mud and water can reduce the capacity of a haulage system as much as one-third or more. Proper ditching is a major answer to keeping haulage roads dry. If gravity disposal is impossible, sumps should be constructed to receive the water and facilitate dispoal by pumping. The importance certain mines ascribe to dry haulage roads is attested by a program of building cisterns in crosscuts at strategic points and equipping these with automatically controlled pumps discharging to an outside line.

GRADING—Eliminating humps and hollows not only makes for smoother, safer haulage but also can result in a significant saving in number of locomotives and crews necessary for a given tonnage. If possible, sustained grades against the loads of over 1¼ or 1½% should be avoided. If averages higher than that cannot be avoided, then it is even more essential to knock off peaks.

CONSTRUCTION—Real money can be saved by mechanizing track construction, starting with loading to handle rock. In some instances, it may be possible to do brushing with a continuous mover to achieve the desired grade. And in the final operations, special ballast cars and mechanical tampers cut labor requirements substantially. In one instance, two men using the machine, align and tamp over 400 ft of track a day, compared to 100 ft by five men using hand tools. Special cars distribute ballast at this property, receiving it through a borehole from the surface.

CLEANING — Smoother, faster haulage, less track deterioration and greater safety are the major reasons for emphasis on clean track. Track-cleaning machines naturally reduce the cost to a minimum, while cars in good condition reduce spillage and stretch out the interval between cleaning.

LIGHTING—Safety, speed of operation and maintenance all are facilitated by good lighting of haulage roads. The latest types of units are fluorescent tubes, which provide a significant increase in light output for the same current. For a discussion of fluorescent lighting in working sections, and of incandescent lighting along haulage roads, see *Coal Age*, February, 1956, p 84.

Incandescent lamps were the original light source, with the usual spacing as 75 to 100 ft. With the usual wattage of lamps, this normally is sufficient to comply with the rule that there should be no dark spots between lamps. Glare elimination requires proper location, and if necessary, shielding. Mounting lamps along one rib, rather than in the center, may help in glare reduction.

HAULAGE HELPS — New ideas for speeding haulage and reducing maintenance include railwashers on locomotives, flange oilers, defective-wheel and bent-axle detectors, etc.

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2. Sequence starting, outby drive first, with proper time delay for each subsequent drive.

3. Automatic stopping of all inby conveyors or elevators if any belt should stop for any reason. The usual device is a centrifugal switch.

4. Interlocking conveyors or elevators feeding to a belt to prevent feeding onto one already full loaded. Devices include finger- or paddle-actuated switches, as well as the wheel-actuated devices described elsewhere in this section.

5. Providing overload or pileup protection at belt transfers, using paddles or other devices to actuate switches and shut down the inby drive. These switches should be of the momentary-contact type so that the inby conveyor will start again when the overload is cleared ready to run coal again.

6. Providing a means of stopping the conveyor anywhere along its length to permit the beltman or any man riding to stop the belt at any time. Continuous pullcord-type controls fastened to the roof also provide protection against falls.

7. Providing drive-pulley slippage control to stop the unit as soon as slippage occurs. A centrifugal switch with pulley riding on the belt, or a centrifugal switch driven by a chain from the bend or snub pulley are two possible devices. A third is a differential control with two pulleys, one riding the belt and the other the drive pulley so that when one gets out of step the drive is stopped.

BELT CLEANING — A number of devices, each more or less satisfactory, have been developed for cleaning belts before they go onto the return idlers. One is a length of piano wire mounted under the head pulley and almost touching the belt (*Coal Age*, November, 1952, p 89). A recent development is a spring-tensioned rubber blade (*Coal Age*, January, 1959, p 127).

DETECTING BELT TEARS—One of the few practicable methods of detecting major tears in operating belts has been developed at a middle western mine (*Coal Age*, January, 1956, p 88). It consists of a horizontal rod 2 in front of the head pulley. When struck by a torn flap thrown out from the belt by centrifugal force, the rod is knocked down to open an electrical switch and stop the belt until it receives attention.

Hoisting

IN THE ABSENCE of special circumstances, the belt slope is the usual coal hoisting facility installed today. Low operating labor and low maintenance are the major reasons.

FEEDING TO BELTS — Any of the standard types of dumps may be employed in transferring coal from mine cars to the belt, unless bottom-dump cars are employed. If so a necessary intermediary is a hopper or bin. Where belts are used for main-line haulage, boomed shuttle belts are used to lay the coal down in a longer and therefore larger-capacity bin. Short transfer and speed-up belts also are used between hoppers and slope belts to take the shock and protect the slope unit from some of the wear and tear. Magnetic tramp-iron-detection equipment on either the speedup or main slope belt stops the equipment and permits removal of metal that might result in damage.

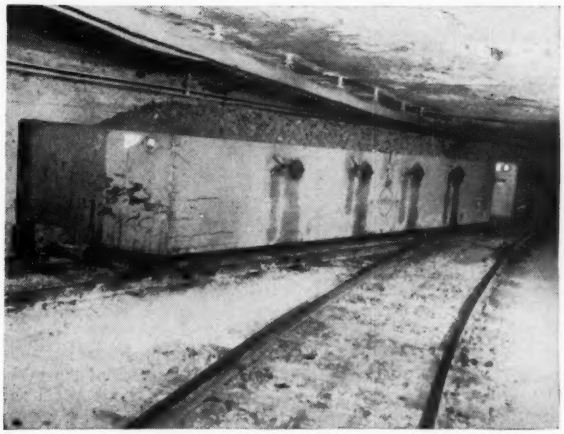
Shaft Hoisting

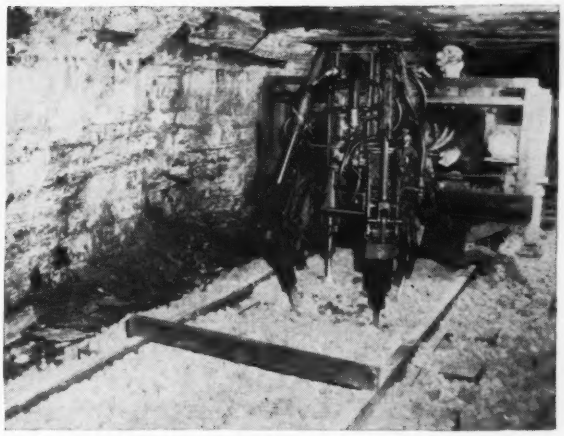
The skip hoist usually raises the equivalent of 2 or 3 cars each trip and thus normally can operate more slowly, with lower acceleration peaks. Where self-dumping cages are employed, fabricating them of high-strength alloys or aluminum reduces dead weight and consequently improves the hoisting operation.

As with all other mining operations, economy in hoisting is a matter of equipment and controls to conserve manpower. Now, any type of vertical hoist-skip, self-dumping or overturning cage, and platform—can be made completely automatic, including caging and, with platform equipment, decaging.

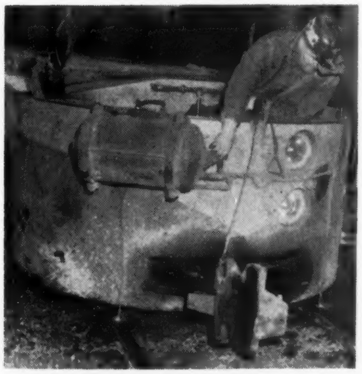
Handling Men

PROPER PORTAL LOCATION or relocation provides, among other things, an opportunity for streamlining the handling of men and also attaining maximum convenience and comfort in changing in and out. A collateral benefit is an up-to-date field



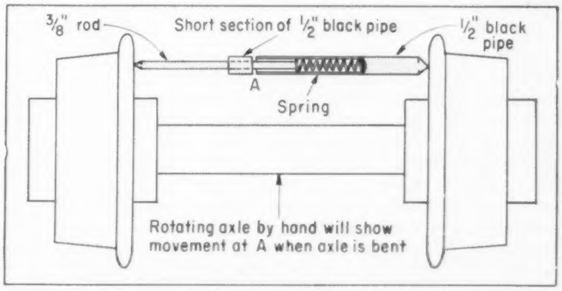


TRACK-CONSTRUCTION COST-CUTTERS include ballast-spreading car (left) and mechanical tie tamper.

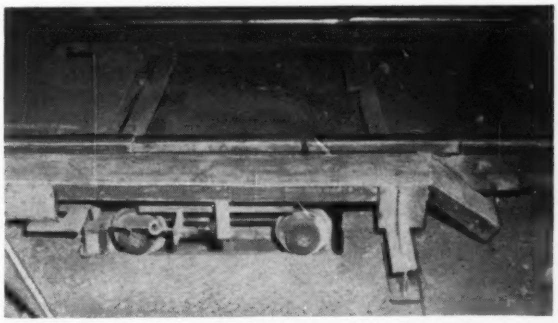


RAIL WASHER on 50-ton locomotive removes sand from rails, thus providing a smoother surface for easier car movement.

SHOP-MADE DEVICE makes possible speedy detection of slightly bent axle which is not noticed in visual inspection. Excess flange wear is thus prevented.



DEFECTIVE-WHEEL DETECTOR in rail at rotary dump operates light at dump control, alerting operator to trouble.



supply setup, with possibly also a field maintenance shop that is much nearer the active workings.

HOISTING — Where men are handled through separate man-and-material shafts, either at the main opening or back at field portals, usual practice today is to install pushbutton-operated elevator-type equipment in capacities up to 50 men.

Drilled shafts with automatic hoists may provide a lower-cost answer to the problem of putting portals close to the working areas. At one mine (*Coal Age*, November, 1955, p 60) a 72-in drilled shaft was fitted with a double-deck circular cage with a capacity of 10 men per deck. Pushbuttons control the automatic hoist. Hoisting distance is 487 ft. Travel time was cut 45 min with a resultant rise in output.

Where men enter through slopes, some mines, where the regular equipment cannot be employed, provide special slope cars for that part of the trip. If single cars are employed, the trend today is to equip them with magnetic track brakes actuated by an overspeed device or by a pushbutton under the control of a foreman or trip-rider. Where several cars are put together in a trip, they can be preceded by a pilot car with magnetic-brake equipment. If men walk the slope, a "ski-tow" installation, which gives them a one-handed pull, is a major help in negotiating stairs in the "up" direction.

CAR TRANSPORTATION — Where height is sufficient, the covered mantrip car is practically standard for transporting men by rail. In addition to cars pulled by locomotives self-powered units are available in capacities up to full section crews, making it unnecessary to detach locomotives for this service. Where several individual cars are in service, dispatching and block signals are essential to prevent collisions. At trackless mines, corresponding equipment on rubber, battery-powered, is available.

BELT TRANSPORTATION — Under proper safeguards, movement of men on belts has proved both safe and efficient. The major safeguards include ample vertical clearance all the way, extra clearance at points where men get on and especially where they get off, equipment to reduce speed to approximately 200 to 250 fpm, and an emergency stop cord or stop system all along the belt so that any man can stop it at any time. The system should be designed so that the belt cannot be restarted without a check to see that no hazard is involved. A space of at least 6 ft must be maintained between each man on a belt.

Ample clearance and smooth unencumbered footing should be provided at all loading and unloading points. Finally, in addition to all other steps, no movement of men on belts should be permitted except while a responsible supervisor is present.

In addition to level movement, special low-speed low-cost belts now are employed in hoisting men up slopes (*Coal Age*, September, 1958, p 130).

Deep-Mining Guidebook . . .

Ventilating Today's Coal Mines

Since 1955

Dilemma of whether to seal or ventilate worked-out sections has been resolved in most instances in favor of ventilating through well-planned bleeder systems.

Weight of emphasis on improving ventilation at the immediate face has increased during the past 6 yr.

Ahead to 1965

More installations of auxiliary ventilating units, on machines and in sections, with increasing use of ducting materials.

Possible development of dust-control systems and methods for fully-effective allaying at the face.

VENTILATING A MINE is somewhat analogous to the pumping of liquids. In both cases, a pressure system is involved, employing (1) a power-consuming device somewhere in the circuit to create a pressure differential, (2) closed conduit to carry the pressurized fluid and (3) a discharge to the atmosphere. Safe, economical ventilation consists of taking maximum advantage of the pressure differential to scour all active openings with fresh air, then to reject the refuse of the process through the return airways into the atmosphere, avoiding the use of excessive power to project the discharge stream into the atmosphere.

Achieving maximum advantage of the pressure differential is the core of the ventilation engineer's job. It is also a prime job requirement of all legally certified mine officials. Stripped to its essentials, the job of ventilating a coal mine involves the following:

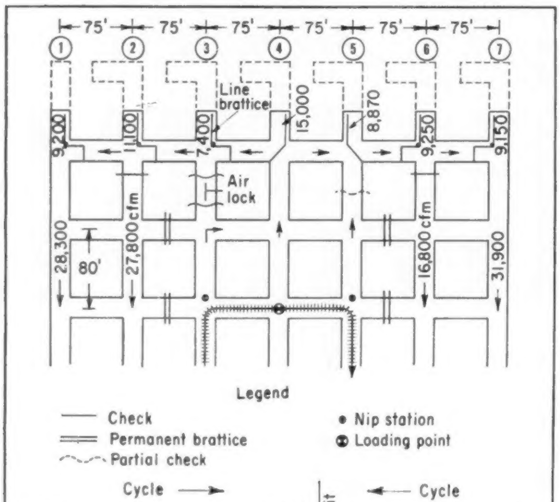
1. Employ an efficient fan that will provide a pressure difference of such magnitude that the desired quantity of air will flow against the resistance offered by the airways.
2. Keep this resistance to a minimum—by providing sufficient airway area—to minimize the amount of power required at the fan to create the pressure difference.
3. Split the air current to insure safer ventilation of individual areas of the mine.
4. Introduce regulation as needed in the low-resistance splits to balance the system.

Coursing the air within the splits requires strict supervision and iron-clad discipline, especially in continuous-mining sections. Furthermore, a management decision will have to be made as to whether worked-out areas are to be sealed or ventilated. A decision to ventilate these areas means that a system of bleeder openings must be designed. Then the entire circuit must be patrolled and maintained because a coal-mine ventilation system grows longer and more complex every working day.

Basic Principles

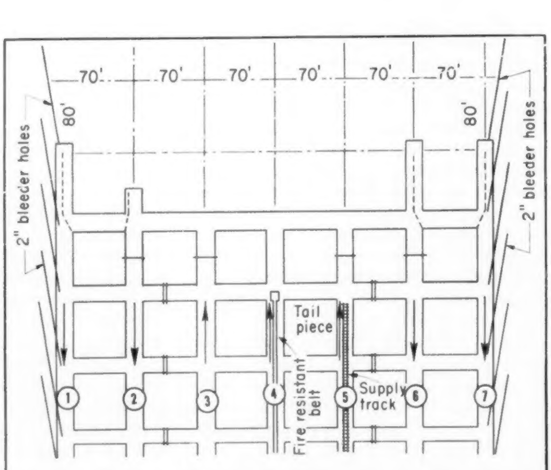
MOST of the effort in designing or updating ventilation systems is put forth with one eye on the power bill, since the goal is to provide adequate ventilation at minimum power. And following back from the power bill, it is seen that keeping the velocity of the air within reasonable limits is a basic requirement because power varies as the cube of the velocity; pressure varies as the square of the velocity, while quantity varies directly with velocity.

Improvements in varying degree may be achieved by cleaning up airways to reduce

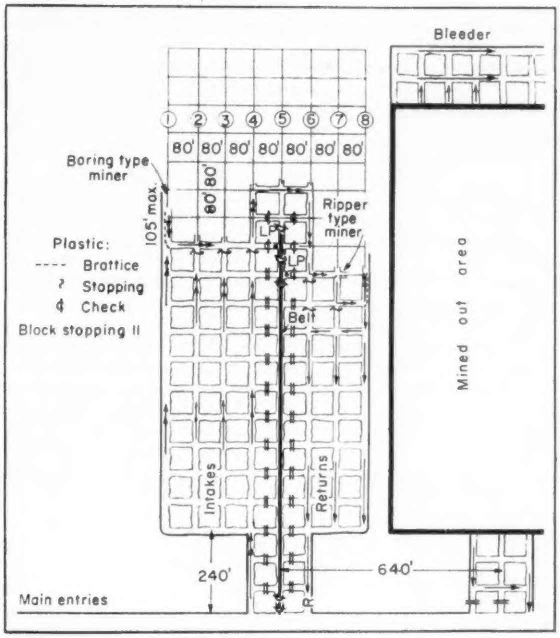


Cycle → ①	②	③	④ Air split	⑤	⑥ ← Cycle	⑦
Drill and cut	Idle	Roofbolt	Load coal	Shoot	Shot	Shot
Shoot	Drill and cut	Idle	Roofbolt	Shot	Shot	Load coal
Shot	Shoot	Drill and cut	Idle	Shot	Load coal	Roofbolt
Shot	Shot	Shoot	Drill and cut	Load coal	Roofbolt	Idle
Load coal	Shot	Shot	Shoot	Roofbolt	Idle	Drill and cut
Roofbolt	Load coal	Shot	Shot	Idle	Drill and cut	Shoot
Idle	Roofbolt	Load coal	Shot	Drill and cut	Shoot	Shot

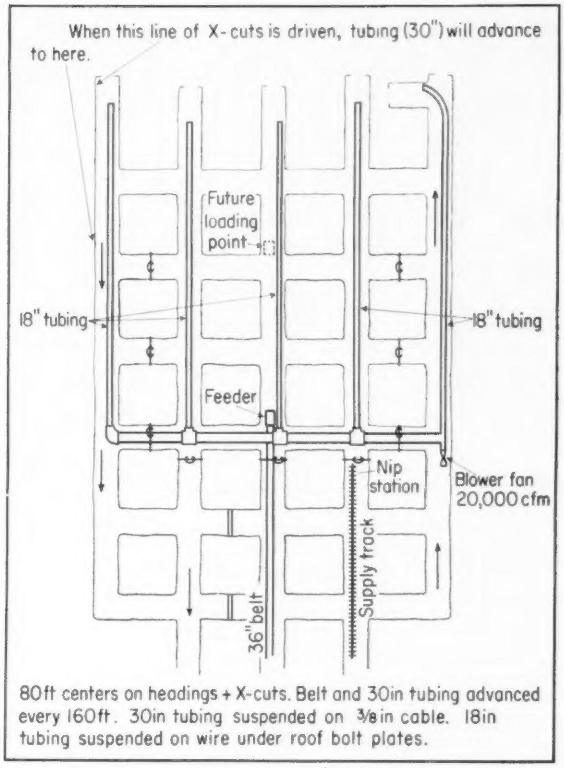
IN CONVENTIONAL MINING better face ventilation is achieved by splitting two ways at the face and cycling to avoid blasting fumes.



DEVELOPMENT PLAN includes advance drillholes in solid-coal areas to drain methane evenly.



MULTIPLE-ENTRY section is advanced and retreated by two continuous miners, including driving bleeder-entry hookup as last phase of development. Line curtains and checks are made of airtight plastic sheeting.



AUXILIARY FAN and tubing supply adequate volumes of air to entry faces in this system in a 20-ft-thick seam.

resistance, sealing leakage, splitting and regulating in the most efficient manner, shortening the distance of air travel through the use of new airshafts and other such steps.

Even at mines where the ventilating duty is governed by the amount of methane made in the workings and the necessity of diluting it and sweeping it away, there is the possibility of draining off some of the methane through boreholes tapping the solid coal ahead of the mining.

Ventilation Surveys

WHEN THE JOB at hand consists of planning a ventilation system for a new mine, the officials in charge of the work should avail themselves of all information and experience offered by others who have conducted operations in the same seam or area. Helpful leads and precautions will be brought to light that will result in the highest degree of modernization in the equipment and plans for ventilating the new property.

This search for available experience and information is particularly important if the new mine is to employ continuous-mining methods. Steps can be taken from the day ground is broken to insure that sufficient air is made available to working sections to effectively serve continuous-mining faces. This is one aspect of reconnoitering the situation in approaching a ventilation problem.

More often, however, the engineer or mine official is required to improve an existing system in order to reduce costs or increase ventilating efficiency at the face. The first order of business in modernizing an existing layout should be the completion of an accurate velocity-pressure survey. This reconnaissance will identify regions of high resistance or excessive velocity and will help determine the extent of wasteful leakage and the locations of leaky control devices.

Some companies have found it advantageous to feed data from ventilation surveys to electric-analog network analyzers to get a picture of air-flow distribution without pursuing laborious calculations. The Bureau of Mines operates one of these units.

Equipment, Materials

MODERN FANS, with few alterations in mine conditions, often can effect substantial reductions in power consumption, partly because of the inherently higher efficiency of the new units and partly because the new fans can be more closely matched to mine characteristics. Quick blade adjustment makes it relatively easy to keep mine and fan more closely paired.

Better design in ventilating materials is not confined to fans alone. Also available are improved curtain materials, including treated cloth and neoprene-coated types. The latest item in this line is a plastic check curtain with a transparent center panel to aid shuttle-car operators.

REUSABLE MATERIALS—New materials for stoppings include telescoping metal sections and sheet plywood. Noteworthy features in these are rapid installation for savings in labor and full reclamation for savings in supply costs.

Not to be overlooked in the list of reusable materials are cinder blocks. However, there are vast differences in the permeability of cinder block, both among the products of different manufacturers and among the lots of the same manufacturer. Giving more attention to specifications in the purchase of blocks and to testing the blocks upon delivery will result in reduced leakage through stoppings.

Prefabricated materials, corrugated pipe sections for example, may be used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful aircurrent controls. As a result of these developments, overcast is no longer a bad word in ventilation.

The main point to remember in constructing overcasts is that causing the air to pass through abrupt changes in direction or area results in excessive losses in useful ventilating pressure due to turbulence and shock. The cross-sectional area of the overcast may be less than that of the approach without resulting in appreciable losses, if the approach is gradually narrowed down to the area of the overcast. The object is to simulate, as near as possible, a true venturi section.

AUXILIARIES—Auxiliary air movers, including fans and portable evase units for the control of compressed air, may be of

some help when properly used with the approval of regulatory agencies. Better ventilation in continuous mining has been achieved through the use of auxiliary exhaust fans and flexible tubing. Installed with safeguards against recirculation, the fan provides adequate air at a velocity which is sufficient to remove dusts to an appreciable degree, improve visibility at the face and dissipate the heat generated by the face equipment.

At least one installation of an inertial, wet-type dust collector has been made on a boring type miner to perform the combined duty of passing air across the immediate face and precipitating dust. Others are seeking practical ways to mount auxiliary blowers, exhausters or diffusers directly on the mining machines in order to provide a source of air that moves up as the miner advances.

Controlling Costs

SKILL AND IMAGINATION in applying the well-known fundamentals in particular conditions lead to lowest costs for ventilation. The advantages to be found in modern ventilating equipment may be fully realized or they may remain undeveloped, depending upon the degree of care and skill employed in conducting the air through the workings. Excessive leakage and insufficient airway area are especially wasteful, no matter how efficient the fan.

Fugitive air is the most expensive luxury in today's coal mines—and the most dispensable. Surveys of some mines show that up to 80% of the air moving through the fan never reaches the working faces. It leaks through poor stoppings, around doors and so on, back into the returns without moving anywhere near the active sections. Even in mines where ventilation is given more serious consideration leakage may short-circuit up to 30% and more of the incoming air supply.

PREVENT LEAKAGE—The penalties in fugitive air, measured in terms of wasted power, are shocking in some instances. Since a certain quantity at the face is mandatory, fan speed must be increased to insure that effective face ventilation, over and above leakage, will meet these legal requirements. And power consumption increases as the cube while the increase velocity contributes to still more leakage.

Sealing at points of excessive leakage is one way to lick the problem. As previously mentioned, cinder blocks differ in permeability, and it has been found that cinder-block stoppings can be made more airtight by applying a coat of plaster. A coat of paint over the plaster provides a still tighter seal. One company has sealed hundreds of stoppings by mixing portland cement with the slurry in a wet rockduster, then applying the mixture to the stoppings in the conventional manner of wet rockdusting.

Another way to reduce leakage is to look for ways to achieve one-way flow, thus eliminating leakage opportunities by doing away with side-by-side intakes and returns separated by porous stoppings and other leaky control devices. Air-shafts or openings to the outcrop may be used as new fan locations or additional intake openings to get the one-way flow. Even in deep cover, the cost of a new shaft may be more than recovered in a reasonable time in power savings alone.

Furthermore, the cost of sinking a shaft is not what it used to be. In one instance (*Coal Age*, June, 1958, p 106), a shaft was sunk by drilling a circle of large-diameter holes with an overburden drill, then shooting the hard core against the relief provided by the drillholes. The job was quickly done with fewer men and in greater safety.

In another area where numerous wants and faults occur, it is found that a pressure system is best in ventilating long narrow gassy areas of coal so long as bleeder shafts are provided at the extremities of these coal areas. As soon as the limit of these areas are determined by completion of development work, a bleeder shaft is drilled down to the coal to remove the gas-laden air from the pillaring sections. Loose ground through which the bleeder shaft is to be drilled is consolidated by grouting. Then a 36- to 48-in hole is calyx-drilled to make the bleeder shaft.

One-way travel contributes to even bigger power savings inasmuch as a change to this system results in increased airway area with former returns now serving as intakes. The upshot is either reduced velocity for the same quantity or higher quantity at the same velocity, a bonus either way.

Coursing the Air

INCREASED SAFETY is by all odds the reason for splitting air current underground. An explosion in a mine ventilated by one continuous current of air could affect the entire mine, while in a mine served by several splits the effects would be more confined.

There are other good reasons for splitting. The mine resistance is reduced, power is conserved, and better local control of the air becomes possible.

The ideal situation, which slows all splits naturally balanced in resistance, is seldom achieved in actual practice, since in some splits development work will predominate and, in others, room work. Some regulation becomes necessary to raise the resistance of all other splits to that of the longest or high-resistance split. Up to a point regulation is helpful, but it can become wasteful.

It pays to investigate the possibility of using an auxiliary fan to serve the high-resistance split alone, thus eliminating any need for adding resistance in the other splits. The benefits are reduced power requirements and lower pressure differentials on stoppings outby the booster fan.

Sometimes a well-planned cleanup in the free split may result in the passage of more air, also reducing the need for added regulation in all other splits. Some companies have found a ventilation bonanza by rehabilitating old airways with roofbolt support in place of timbers. The resulting increased area and decreased resistance work together in compounding the benefits.

FACE VENTILATION — Recent studies indicate that getting a sufficient volume of air up to the face crosscut is not the big problem. In continuous mining the big problem is to conduct this available air across the "teeth" of the machine, right at the immediate face. Even a well-constructed line curtain may leak most of the intake air before it comes anywhere near the face. If line curtains are used, their installation must be closely supervised in every instance.

Elimination of doors and checks across shuttle-car roadways is accomplished at one mine by diverting intake air around dumping points in the belt entry. The system is based upon 3-heading entries in room panels, with the panel belt in the center heading. Two well-constructed checks are built across the belt heading on either side of the shuttle-car dumping point and a stopping is erected in the entry breakthrough between these two checks and on the side of the belt opposite the dumping point. Intake air is thus diverted around the dumping point to the outer heading. It returns to the center heading beyond the dumping point.

Air for Safety

ACCUMULATIONS of gas in worked-out areas are especially hazardous in today's coal mines because of the rapid extraction in highly mechanized methods and the consequent increase in the rate of methane emission. The worked-out area increases rapidly, close by the active places where a number of electric-powered machines are concentrated and the entire crew is assembled.

In conditions like these, more and more operators are including bleeders in their mine projections to ring gob areas with openings through which air passing through the gob may be conducted directly to the returns. In some instances, air from the worked-out areas passes into the returns through regulators which control the quantity of air passing through the gob as well as insuring adequate air and positive pressure along the pillar line. Properly maintained bleeder headings practically eliminate the possibility of gas migration during periods of low pressure.

Along similar lines, it is advantageous in gassy conditions to begin recovery of room panels by driving a pair of line rooms along the outby limit of the panels parallel to the mains. Such rooms serve as an extra pair of low-cost airways, and the outby room may be preserved in the bleeder network after the panel has been robbed.

Also in the field of safety are designs for automatic methane detectors which will interrupt line power to electrified face machines when methane content rises to a predetermined value. And more and more mines employing multiple fans are turning to the use of automatic monitoring systems to provide centralized information on fan outages. These systems of fan control are coupled with definite rules for inspection of fan stations when the monitoring system indicates an outage. Self-closing doors associated with each fan in multiple-fan systems prevent reversal of airflow which would further complicate the situation. A wise practice at such mines is to take advantage of idle days and vacation periods to study the changes in distribution of air as each fan is shut down in turn.

Mine Drainage and Pumping

Since 1955

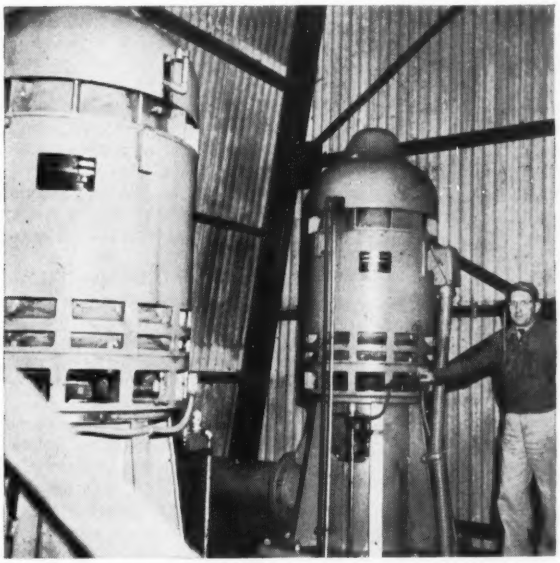
Cumulative problems with water, especially in anthracite, tie survival of operations to efficient pumping.

The real public interest in clean streams dramatized the need to keep water out of mines.

Ahead to 1965

Reduced drainage costs through less rehandling of water may hasten development of regional pumping stations.

Use of chemical grouting materials is likely to grow as a means of sealing surface and underground water channels.



HIGH-CAPACITY pumping station represents a large capital outlay. Pump manufacturers can be of great assistance in tailoring the equipment to the job.

ONE LARGE PUMP and two small ones, selectively operated as necessary, create maximum flexibility in this underground station.

DETAILED PLANS for handling water will have to be made at most mines. Procedures for getting the job done, in order of preference, are (1) keep the water out of the mine, (2) return it to the outside by gravity flow if it does get into the workings and (3) design for high-efficiency pumping through the straightest, shortest pipelines it is possible to achieve, using boreholes to the surface or outcrop wherever this opportunity presents itself.

Mine drainage is somewhat like mine ventilation, in this respect:

The most efficient fan in the world cannot provide low-cost ventilation if the airways present high resistance, if excessive leakage is permitted or if expansion of the workings outruns the plans for extending ventilation. Similarly inherently high efficiency in a pump can be diluted if suction and discharge lines are poorly designed and installed, if excessive labor is required to maintain the lines or if pump operation requires attendance.

However, first order of business in drainage is to keep the water out.

Gravity Flow And Diversion

COMPARE THE COST of constructing a longlife diversion flume against the cost of power for raising the same amount of water from the workings over the life on the flume. Such a cost analysis may prove that the following steps will provide economic advantages.

Diversion ditches around openings, sealed stream beds at troublesome points, grouting underground to seal off stream channels, new channels if necessary and well-constructed dams are possible controls which may be used to keep water out of underground workings. Flumes make it possible to conduct surface water across pervious areas of mining properties and dump it back into natural drainage channels on the other side.

It is neither possible nor practicable in most instances to keep out all water. Some provisions must be made for handling underground inflow.

Other things being equal, it may be possible to lay out the mine so that workings advance to the rise, giving an assist to haulage as well as to drainage.

USING BOREHOLES—In other instances, it may be possible to drill boreholes to the cropline or into a sump area to permit gravity flow by the most direct path.

SUMPS IN DIP WORKINGS—At a new mine, where the seam dips 8%, room panels are worked to the dip from strike entries on advance and up the pitch on retreat. The idea is that the dip workings are finished before extensive areas have been opened up,

and the dip rooms will serve as sumps for the uphill workings.

When all's said and done, however, chances are some pumping will have to be done. But handling water with today's equipment is a far cry from the difficult job it was in the past. Today's advantages include efficient pumps for any type of duty, electric power in place of steam, automatic controls to cut the cost of operation and materials designed for long life at reasonable cost.

Selecting Pumps

Don't specify a pump. Specify the conditions under which the pump will have to work, then discuss the details with a pump supplier. The type of pump selected depends entirely upon the pumping job to be done. In two out of three of today's mine-drainage applications, centrifugals of one type or another will be found, but each of these is practically a tailor-made unit.

SPECIFYING CONDITIONS — The pumping job at one mine may be entirely different from that of its nearest neighboring mine with regard to such factors as volume, total head and water acidity. The best bet, therefore, is to work closely with a pump manufacturer in determining the one best pump for the application.

The final selection will depend upon whether the service is to be continuous or intermittent, whether AC or DC power is to be used, how much water is to be handled, how much variation may be expected in suction and discharge heads and so on.

SPECIAL CONSIDERATIONS—If the water is free of solids, a multistage centrifugal unit to work against a high head may be used, but if solids are present a number of single-stage units in series should be used because solids ruin multistage pumps. Thus pump selection becomes an exercise in balancing a number of sometimes-conflicting factors.

Also important in selection is a decision as to whether the total pumping capacity should be provided in a single unit or in twins, with the latter choice getting the nod in most recent installations.

Foresight should be used in arranging the pumping schedule to dovetail with operations. For example, at a three-shift mine it may be desirable to provide "peakless" pumping to spread the pumping load over the entire day, while at a two-shift mine it might be better to provide enough capacity to handle all the water on the off shift when demands for production power are at a minimum. In either case, sump capacity will have to be planned and provided to suit the system finally selected.

And in certain special cases, it would be well to investigate the possibility of "community" systems among several mines or companies.

Planning Pipelines

USUALLY THE MAJOR VARIABLE which is amenable to some measure of control is the friction head in the piping itself. The quantity to be pumped is a definite figure and the static head is fairly fixed, but the friction head can be held to a minimum by designing for the largest-diameter, straightest pipeline it is possible to achieve.

Small pipe and numerous fittings and turns will extract a penalty in the form of either higher power requirements or reduced volume of discharge.

In the normal case, pipe of the largest usable diameter will be most economical in the long run.

SPECIAL-PURPOSE UNIT is this belt-driven pump for dewatering local swags.

KEEPING THE WATER out of the mine is the first order of business.

SYSTEM DESIGN — A well-designed pump installation will show these features:

1. The suction line leads straight into the pump for a length equal to four to six pipe diameters.
2. The suction pipe is one or two sizes larger than the pump nozzle, and it is connected to the pump through an eccentric reducer which is properly placed to eliminate suction-line air pockets.
3. The drive motor and pump are in good alignment.
4. The piping is supported so that the pump carries none of the pipe-line weight.
5. Priming auxiliaries, if they are needed, and lubricating facilities are in good working order.

Priming water for one underground pumping station is taken from the dust-allaying spray water system. An automatic cut-off is provided to disconnect the spray system as soon as the pump takes up its load.

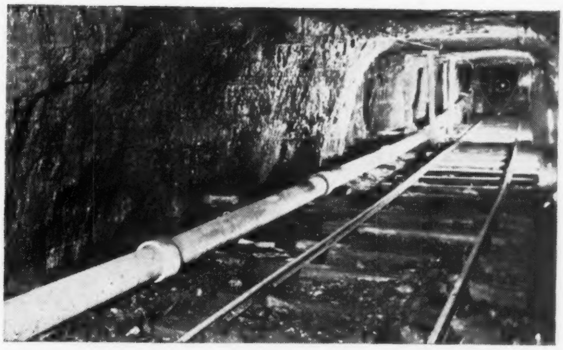
Furthermore, all large drive motors should be equipped with protective devices that will interrupt power in the event the pump fails to pick up its load.

Special Projects

Fitting the pumping system into the overall mining plan is another matter. This is another instance where each setup is somewhat different from any other, as local conditions dictate. An example of how to get the most out of a dollar of drainage cost is demonstrated at one mine where three gravity-fed sumps and three pumping stations remove 3,000 gpm in three stages over a distance of 3 mi. Each station is provided with independent pumping power through a borehole cable. Wood pipe in 8-, 10-, 12- and 16-in diameters is used.

The two main pumps at this property operate on alternate 12-hr cycles thus making a peakless pumping load on the power system. The sumps act as accumulators in making this pumping schedule possible.

DEWATERING—At an anthracite mine the problem was to unwater some workings on the other side of a 200-ft barrier pillar to permit recovery of the pillars in the flooded mine. Broken strata above the workings ruled out the possibility of using a borehole to the surface. The solution was to drill a pair of 12-in horizontal holes from the active mine through the barrier pillar to tap the flooded workings. The borehole lines were connected to a 7,000-gpm 700-hp pump which discharged through 2,300 ft of 18-in asbestos-cement pipe installed in the slope of the active mine.



ASBESTOS-CEMENT and plastic piping and quick couplings permit faster installation or relocation of pipelines.

Specially-designed pipeline equipment reduces drainage service labor

LARGE-DIAMETER BOREHOLES—At another anthracite property it proved to be more advantageous to drill two 24-in boreholes from the surface to a depth of 537 ft to reach the best natural sump in a worked-out lower vein. Upper veins then could be drained into this sump through smaller boreholes which were drilled at intervals as the workings advanced to keep the pipelines to gathering pumps as short as possible. The two larger boreholes each serve a 4,400-gpm 10-stage pump, driven by a 700-hp 4,000-V AC motor.

Incidentally, both of these anthracite drilling operations were let out on contract to a company that specializes in these projects.

CHEMICAL GROUTING—A new assist in the control of subterranean water is provided in a non-viscous chemical solution that will penetrate any mass through which water flows, then turns into a stiff gel in a controllable period of time. The material is available as a powder, it is dissolved in water at point of use, and catalyst is added to control gelling time.

Lower-Cost Water Handling

THE SYSTEM must now be operated and maintained with minimum expenditure of service labor. This means that pumps and other drainage equipment must give longer trouble-free service, pipelines must last longer, relocations of pumps and piping must be made in less time, and long runs of piping must be installed in the shortest possible time.

Every manufacturer of drainage supplies designs his equipment to perform one or more of these functions. Here are some examples.

Saving Labor in Pumping—Pump controls ranging from simple float switches to elaborate fully-automatic systems for large stations are available. Modern pumps can be made of special alloys or lined with coatings which increase pump life in handling corrosive waters. One anthracite operator found he could increase the interval between overhauls by painting pump interiors with special insulating varnish, normally used in electrical applications.

Longer Pipe Life—Asbestos-cement, plastics, aluminum alloys, synthetic rubber, special coatings—all these materials in the form of mine pipe have materially increased time-in-service for pipelines. A new offering, now on the market, is a line of grooved pipe fittings, in malleable iron or aluminum up to 12-in diameter, which are lined with polyvinyl-chloride.

Faster Relocation—Fast snap action couplings for use with plain-end pipe now permit fast disassembly and reassembly in a new location of pipelines up to 6 in in diameter. Grooving machines now are available for modifying plain-end pipe to take the faster self-aligning couplings.

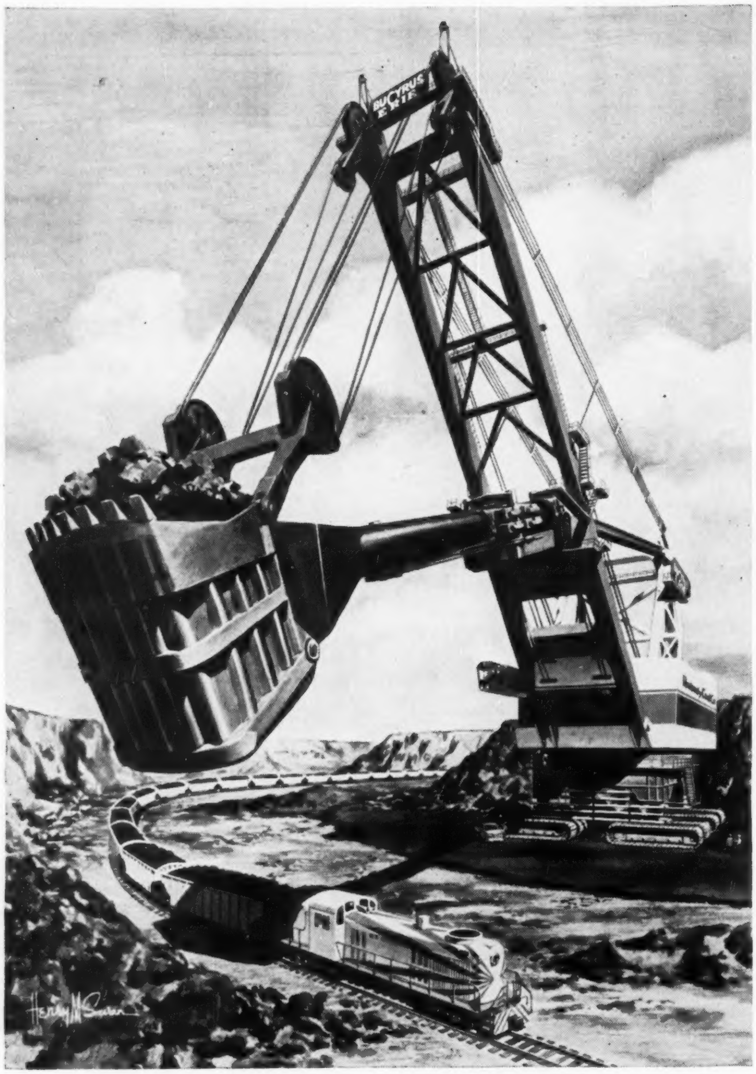
Quick Installation of Longer Runs—Long coils of lightweight plastic pipe or long sections of aluminum pipe now can be installed by one or two men, where the same men formerly would be hard-pressed to lay a fraction of this length in the same time.

Clean Streams And Pipelines

ACID-CONTROL CONSIDERATIONS may have more effect on your pumping schedules than the technical aspects of the matter, such as volumes to be handled, peak periods and so on.

The pressure on preventing acid mine water and mine-waste solids from entering public waterways is mounting year by year. In designing drainage systems and arriving at pumping schedules, mine operators may have to weigh their plans in favor of fast removal of mine water to prevent long contact with sulfuritic materials. In some instances, this may be an overriding consideration in designing for sump and pump capacity.

Faster handling of mine water will also be helpful in delaying the buildup of "yellow boy" in pipelines, and in lessening the corrosive effects of the highly-acid water that would result if the water were allowed to stand in the mine. The end product of this kind of planning will be longer lasting pipelines, which means additional savings in drainage-system labor.



Profitable Stripping

CONTINUING pressure for more output with the same initial capital expenditure and the same or lower operating expense places increasing demands on the skills of mine operators. Since the cost of developing a new mine rises each year, the need for planning grows more important each year. Equipment manufacturers are contributing to lower costs by developing new machines or modifying existing units to increase productivity. By planning mine development to use fully the capacity and special features of modern machines, mine management can maintain or decrease costs.

Successful strip mine operation challenges the combined skills of engineering and operating officials. Engineering skills are particularly needed in the planning and development stages of a new mine. Furthermore, modern management recognizes that engineering skills are becoming increasingly important in assisting operating officials in solving day-to-day problems. Teamwork between engineers and operating officials will become increasingly important in the future as operations become more complex.

Planning for Operation

GETTING COAL RESERVES—Before a new strip mines goes into operation, two fundamental problems should be solved. These problems are: (1) acquiring and consolidating sufficient coal reserves to justify the capital expenditure for mining and preparation equipment, and (2) gathering reliable information about the coal bed and stripping conditions.

Investigating coal properties and evaluating information about the coal seam demands the application of engineering skills. The scope of the engineering study will vary from property to property, depending on the information already available, the topography and the nature of the coal seam. For instance, a company operating deep mines and owning strip reserves in the same seam will not have to make as intense a study as another company considering opening a new mine in a new area.

The size of the property and the topography influence to a great extent the size and type of stripping operation that can be planned. For instance, equipment that works well in flat areas will not necessarily perform equally well in mountainous regions. Furthermore, equipment capacity should be matched to the reserves of coal available. It would not be wise to choose high capacity machines for a mine with limited reserves. And small equipment may not be an economical investment at a property with large reserves.

Information about the coal and the material covering it should be accumulated as quickly as possible as property is purchased or leased. Getting this information is an engineering job that includes topographic surveying, mapping and prospecting.

As rapidly as information is accumulated it should be recorded and analyzed. The numerous questions about mining rights, land ownership, coal thickness and quality, and thickness and type of overburden can be readily answered if all information is funneled to a central office and organized for ready reference.

MAPPING THE LAND — Informative maps in the hands of competent engineers and operating supervisors are important tools in planning development, day to day operation and equipment moves. Modern methods make it possible to produce accurate maps in less than half the time required for ground surveys. And there is no sacrifice in accuracy.

With the aid of low-cost aerial maps, engineers can estimate coal reserves, plot property lines and coal outcrops, locate boreholes, lay out roads, locate spoil areas and calculate overburden ratios. The speed with which these maps can be made also makes it possible to use a monthly progress map to make an accurate, fast calculation of the number of cubic yards of overburden and tons of coal removed, and to direct stripping operation for the next month.

Some field survey control is necessary in aerial mapping. In rough, mountainous terrain, the tellurometer, a new electronic instrument, can cut the time and cost in making field surveys. The device, which applies the radar principle to distance measurement, consists of a monitor and a slave station. Both are completely mobile and can be carried by one man.

When it is not practicable to have an aerial survey made, a ground survey may be needed. The extent of this survey will depend on the topography and whether information is available in the form of government maps and geological bulletins.

If deep mining was done in the area, mine maps on file with the State department of mines will provide a valuable

Since 1955

Application of 60- and 70-yd shovels and start of construction of 115-yd unit. Announcement of the 85-yd dragline.

First production model of the U. S. Wheel excavator

Improvements in mixing and handling of ammonium nitrate-oil blasting agent, including blow charging of horizontal holes and bulk handling to reduce costs.

Development of the rotary dry-type horizontal drill, including the twin-mast unit, for boring holes up to 12 in.

Mechanical tamping of horizontal holes.

Refinements in vertical, rotary drills, and introduction of units that can drill inclined holes.

Seismic analysis of overburden.

Helicopter transportation of mine supervisors.

Automatic liming of pit water.

Ahead to 1965

Shovels with 150-yd dippers and draglines with 120-yd buckets.

Application of 13,000-V power for large stripping units.

Further refinements in drilling and blasting techniques.

Development of simplified controls for stripping units.

Boost in truck capacity to 125- to 150-ton range.

source of information. They will show how close the old workings came to the outcrop and frequently show dip and thickness of the coal, and unusual geological conditions such as faults.

STUDYING THE COAL—As soon as basic maps are available, information about the coal seam and any conditions which might influence mine planning should be gathered. This information should be plotted on maps as it is accumulated.

Drilling is the most satisfactory method of prospecting coal for full and accurate information. This work can be done either by churn- or diamond-drilling equipment. Diamond drilling provides a core section of the overlying rocks and the coal, and therefore yields very valuable information.

Several companies have found it helpful to photograph coal cores to provide a permanent graphic record of the core as well as to conserve storage space. The physical characteristics of the coal are frequently destroyed when a core is split and prepared for analysis. A photograph provides a permanent record of the appearance of the core.

Development of a bottom-discharge bit that prevents air circulation around the core has made possible the successful application of air core drills. Air coring is said to make possible 100% core recovery nearly every time, even when it is necessary to stop half way through a seam. A very important advantage of air coring is that thin, soft partings of clay or other material are not washed out as they would be when using water. Another advantage is that water lines and pumps are eliminated.

A new lightweight handheld diamond coring drill weighing only 45 lb is available for prospecting under as much as 200 ft of cover. In shallow drilling the unit recovers up to an 8-in core and in deeper drilling it recovers a 5/16-in core. One man can operate it on 2 to 2½ gal of fuel per day.

Diamond drilling results have been improved by perfection of the wire-line coring technique for coal prospecting. The wire-line coring method differs from the conventional method in that a retractable inner tube is used. At the end of each run, the core-laden inner-tube assembly is hoisted to the surface through the drill string, as opposed to the conventional method wherein it is necessary to pull the entire string and core barrel to recover the core. Increased coal recovery, lower diamond cost and saving in drilling time are advantages of the method.

OVERBURDEN ANALYSIS—A quick, easy and inexpensive method of determining the consolidation of overburden in strip operations has been developed. The new process, called seismic analysis is based on the principle that sound or shock waves travel through different subsurface materials at varying speeds and along different paths. By this method the operator can determine whether overburden can be ripped or whether it will need to be drilled and blasted. Two men, after a minimum of training, can perform a seismic study in a matter of hours.

If the coal bed outcrops, prospecting should be done at regular intervals along the outcrop. The modern tool for this job is the bulldozer. Once the bulldozer is on the outcrop, it can make an opening faster and more economically than by hand methods. Outcrop openings and trenches extending above the coal bed, can yield other useful information on the type and nature of the rock covering the coal and how much outcrop coal must be removed before merchantable coal is reached.

USING THE DATA—In any prospecting program, sufficient holes should be drilled or outcrop openings made to get an accurate picture of the coal and overburden. Prospecting results, including seam thickness and elevation, should be plotted on special maps as quickly as possible. This information then should be used to construct coal-thickness contours as well as contours of the top of the coal. These two sets of contours along with surface-contour maps are useful in computing overburden ratios and planning stripping methods. Coal-thickness contours are especially helpful in planing operations when the coal bed is not uniform in thickness.

PLANNING RECLAMATION — Two problems demanding more and more attention are: (1) restoring spoil areas to usefulness after mining is completed and (2) preventing stream pollution. The type of restoration work depends on such factors as contour of the land, type of overburden as well as State regulations. Sometimes the only immediate steps that can be taken after completing stripping are backfilling and leveling because the spoil will not support plant life until it has decomposed by weathering for several years. In any event the material in the spoil bank should be analyzed to see if it will support plant life before planting is begun.

Crown vetch has become popular as a ground cover in reclamation work. It has unusually good qualities for soil building and cover purposes. Formerly considered as poisonous to cattle, it now has been proven to be an excellent forage crop.

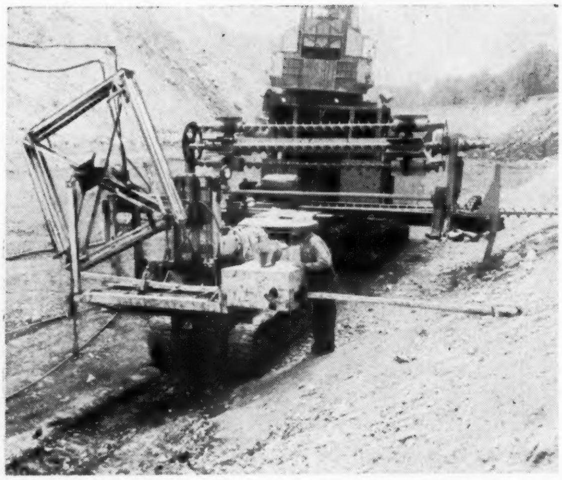
LOCATING THE PLANT—A number of factors govern the choice of a plant site. Among these are topography, access to rail or water transportation, sufficient building area and distance to the coal to be mined. If wet-washing facilities are to be included in the plant, a reliable water supply will be important, along with room for thickeners or sludge ponds. Refuse-disposal area also must be considered in choosing a plant site.

PLANNING MINE LAYOUT—As soon as the preparation plant site is chosen the most advantageous point to open the strip pit should be selected. Then a permanent haulage road connecting the pit with the preparation plant should be laid out. Time and money can be saved by laying out a preliminary road on a topographic map and then making estimates of the earthwork required to make the road. By making this preliminary layout field work will be reduced to such items as marking road alignment, setting grade stakes and making minor adjustments.

Good road alignment and good grades pay off in faster haulage and lower truck maintenance. A solid, well drained roadbed enables trucks to travel at the top recommended speed and keeps wear and tear to a minimum.

The method of attacking the coal is governed by a combination of the following factors: type, thickness and contour of the overburden; thickness, quality and area of coal available. If the coal bed does not outcrop, a box cut will be needed to open the pit. If the coal outcrops a considerable dis-

TWIN-HEAD HORIZONTAL DRILL bores two holes simultaneously on 22-ft centers. Drill masts are independently positioned and operated.



MECHANICAL TAMPER follows high-capacity auger, pushes 50-lb cartridges of explosives and stemming into 80-ft holes. Four primers are used.

tance above drainage and contour mining is planned, it may be necessary to spend a great deal of money to provide a solid, all-weather road to the coal level.

Sometimes it may prove more economical to build a bin, feeder and conveyor to haul coal downhill to the preparation plant and restrict truck haulage to nearly level roads along the outcrop. Whatever the choice of transportation system, the goal is the most economical method possible.

SELECTING EQUIPMENT — Topography, coal reserves, expected selling price of the coal, type of overburden, spoil area and tonnage of coal desired per shift are some of the major factors influencing the selection of equipment. Since other machines should be matched to stripping capacity, the selection of the stripping unit will influence the choice of the other machines.

The capacity of a stripping unit will be influenced considerably by the estimated number of cubic yards of overburden that can be removed to recover a ton of coal at a profit. Once the economic limit is established the stripping unit can be selected.

STUDYING EQUIPMENT RANGES—Profiles or cross sections of the proposed stripping area along with key equipment dimensions and ranges are valuable in selecting the machine or combination of machines best suited to the conditions. This type of diagram will show how wide the pit can be made, what the spoil area will look like and how each machine can be used most effectively.

Consider the needs of a specific property in relation to overall efficiency and cost rather than in terms of dirt-moving capacity alone in choosing a machine.

ESTIMATING MINING COST—An estimated mining cost based on engineering studies is the best guide in determining the economic stripping limit. The estimated figure should include a complete breakdown similar to the accounting method that will be followed when the mine is in operation. For example, labor and material costs should be estimated for such items as drilling, shooting, stripping, explosives, pit cleaning, coal loading, haulage, road building, fuel, oil, grease, maintenance, supervision, depreciation and any other items needed to build up the estimated cost as accurately as possible.

MOVING COST—First cost is not the only expense involved with a stripping machine. It must be erected on the job and perhaps torn down and moved to a new site. Mounting labor costs must be given careful thought in the moving and erection costs of equipment. These two indirect costs alone may set an economic limit to the size of the unit because it is not always possible to amortize equipment during the life of an operation. Where it is not feasible to do this, medium and smaller size machines have the added advantage of low-cost moving to another location.

If the acreage or reserves of mineable coal is not large enough to justify the purchase of a large dragline or shovel, the ability to move a unit to a new site becomes an important factor in equipment selection. Mobility of equipment is particularly desirable for small or medium size companies in acquiring new coal reserves, especially in areas where large strip reserves no longer are available.

BALANCING UNITS—Once the capacity of a mine has been decided and the major stripping machine chosen, other units, such as drills, coal shovels and trucks should be selected to build a balanced production cycle. After the production cycle is established, any change in one of the cycle components will upset the balance. Unless other changes are made, inefficiency will result.

It is sometimes practicable as well as economical to add flexibility to the operation by adding a small or medium size shovel or dragline. For example, a small machine sometimes can be used profitably to remove cover in a tandem operation where a large shovel or dragline takes the major portion of the overburden.

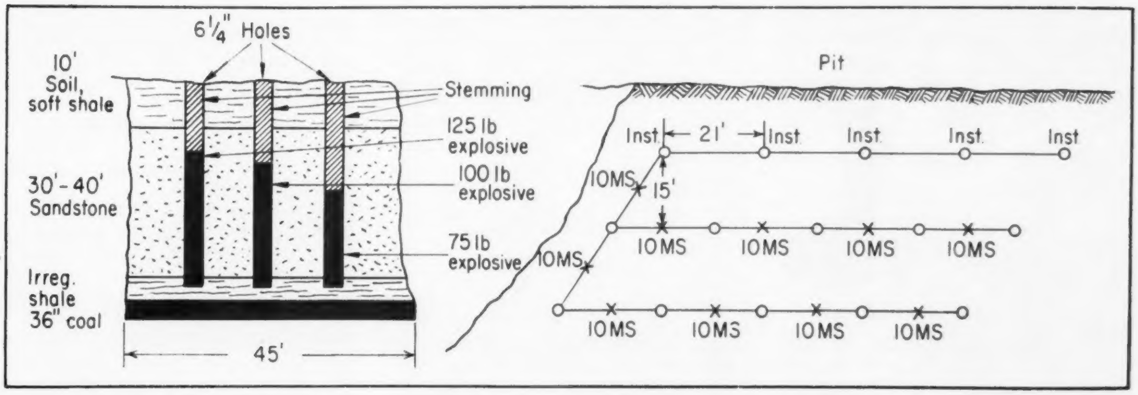
RADIO COMMUNICATION — Where mining plans call for the various machines to be working far apart or in more than one pit a radio communication system is valuable. Money spent on the radio setup frequently can be repaid in better supervision and less equipment downtime. For example, equipment downtime can be substantially reduced because stripping units can report trouble immediately. Thus repair crews and facilities can be called to the scene promptly. If the job requires parts or materials not on hand, they can be ordered from the warehouse in a matter of seconds merely by picking up the microphone and calling.

Another important benefit of radio communication is that supervisory efficiency can be improved considerably by reducing the time needed to cover the ground to check operations. With radio, much of the routine of checking on the progress of stripping and pit conditions can be done by calling the pit, thus reducing supervisory driving to a minimum and leaving more time for planning.

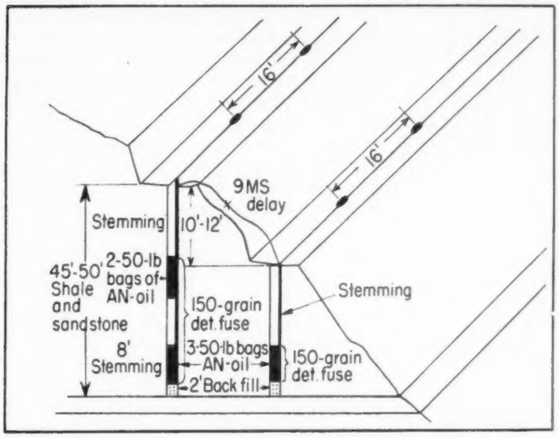
Preparing the Overburden

THE SUCCESS of a stripping operation depends to a considerable degree not only on how well overburden is broken but also on how much it costs to break the material. The objective in overburden preparation therefore is to achieve the best fragmentation possible while keeping drilling and blasting costs within economic limits. In establishing drilling and shooting practices mine management must weigh the benefits of maximum fragmentation against the higher cost of breaking the rock finer. To meet the desire for lower cost overburden preparation, mine operators are now exploring new possibilities in drilling and blasting techniques.

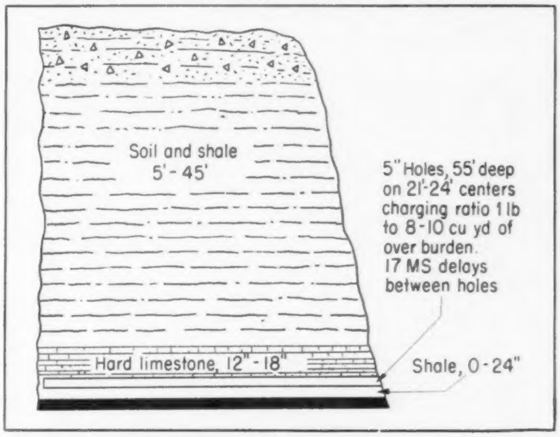
By employing the seismic method of overburden analysis, strip operators can measure the overall consolidation of subsurface ma-



MULTIPLE ROWS of vertical holes with varying charges are effective in breaking bank composed mainly of sandstone.



TWO-LEVEL DRILLING is a common practice in hillside stripping. Deeper holes receive heavier charge.



HORIZONTAL HOLES make it possible to concentrate explosives near hard layers close to the top of the coal.

terials, including rock hardness, stratification, fracturing and the degree of weathering. The seismic method also makes it possible to determine rippability quickly. In some instances where material can be ripped, savings of 12 to 60% have been reported.

VERTICAL DRILLING — Rotary dry-type units lead in drilling vertical holes although improved vertical augers are still proving themselves valuable. A wide assortment of rotary dry-type machines is available to meet the needs of both large and small mines. Some of these machines are mounted on crawlers, others are carried on truck frames. Hole diameter varies from 5½ to 12 in.

Most operators in thick cover and producing large tonnages favor the big crawler-mounted rotary machines capable of drilling up to 12-in holes. These large-diameter holes make it possible to concentrate explosives in the hard layers and to use less-dense low-grade explosives, such as, the make-your-own mixes. They also make it possible to break a larger volume of the overburden with fewer blastholes.

Some typical results with big vertical rotary dry-type machines are as follows:

1. An average of 1,100 ft of 9-in hole in 8 hr while drilling in 50 ft of medium-hard shale covered by 12 to 40 ft of sandstone. Bit life averages 21,000 ft of hole (*Coal Age*, January, 1959, p 59).

2. An average of 625 ft of 10⅝-in hole per shift in hard, sandy shale that ranges from 45 to 70 ft thick. Bit life is 13,704 ft (*Coal Age*, July, 1959, p 108).

3. Up to 700 ft of 9-in hole per shift in shale or shale mixed with sandstone in 40 to 50 ft of cover (*Coal Age*, March, 1960, p 70).

4. An average of 1,200 ft of 6¼-in hole in one shift, using a machine with a 55-ft mast in overburden that includes 30 to 40 ft of sandstone. Bit life is 4,000 to 6,000 ft (*Coal Age*, February, 1957, p 98).

5. In 75 to 100 ft of overburden made up of hard shales and sandstone, an improved-design crawler-mounted unit operated by a two-man crew, drills 400 to 900 ft of 9-in hole in 8 hr. It is able to do in 16 hr a day and one day less per week the work formerly requiring round-the-clock operation 7 days a week (*Coal Age*, July, 1958, p 92).

When drilling through clay or soil with a rotary machine, some companies have experienced difficulty with the hole squeezing together. They have solved this problem by augering through the soft material and then changing to the regular oilwell-type bit. Although this method requires two extra tool changes, the faster penetration of the soft material and elimination of squeezing more than offsets the disadvantages. One Illinois operator saved $8,000 per year in bit cost with this method.

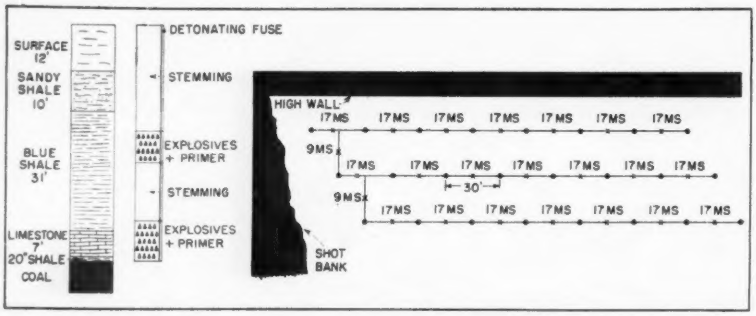
At some mines auger stems are being used successfully with rotary dry-type machines to help bring the cuttings out.

INCLINED DRILLING—A vertical, rotary dry-type overburden drill whose mast can be tilted 30 deg from the vertical went into service in 1960. Mounted on crawlers with independent action, it has a fully revolving frame. Drilling functions are controlled from an air-conditioned cab and its overhead drive can be adjusted to drilling conditions by turning a knob.

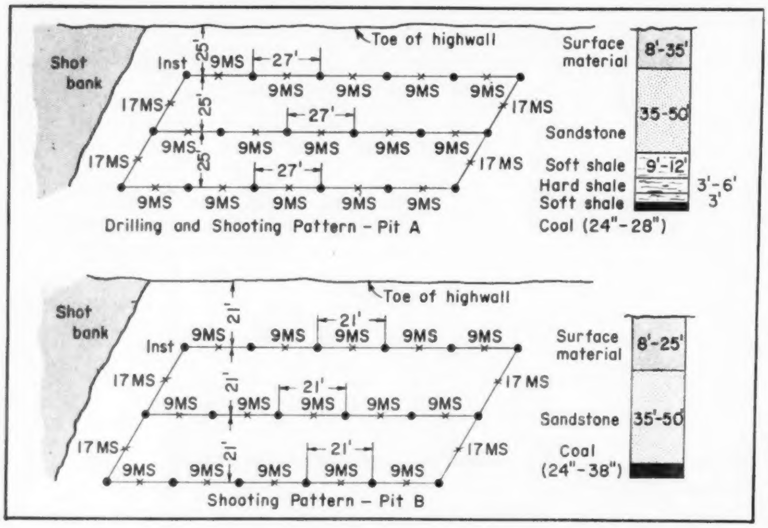
Among the advantages cited for inclined drilling are:

1. Toe problems can be eliminated.
2. Better fragmentation because of better use of explosive energy as well as reduced rock resistance at the bottom of the hole.
3. Less footage per ton of rock and less explosives consumption.
4. Smaller-diameter holes can be used.
5. Throw distance will be greater.
6. Less vibration.

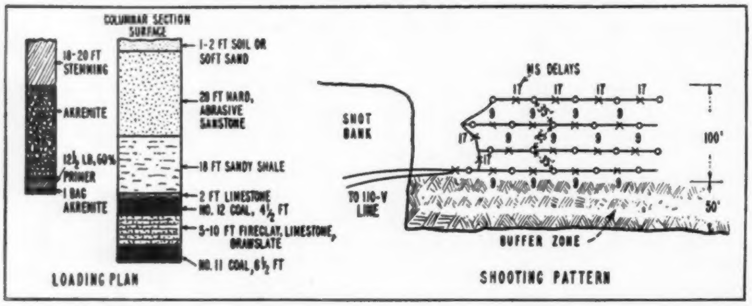
Some research results indicate that a saving of about 1% in breaking cost per degree of inclination is possible with inclined drilling.



DECK LOADING concentrates part of the charge in the upper portion of thick overburden for better fragmentation.



DECK LOADING is also advantageous in overburden consisting of rocks with varying hardnesses. Millisecond delays increase the effectiveness of explosives.



BUFFER SHOOTING makes possible a uniform drilling pattern, eliminates large chunks that are sometimes produced when shooting against an open face.

MOBILE DRILLS—Where flexibility is extremely important and operations are in the medium or small-size range, there are many smaller, lighter and less expensive vertical rotary machines available. Today's designs include both truck and crawler-mounted units, usually equipped to drill 4⅝- to 6¼-in holes.

One of these special units is mounted on a wide-gage tractor, has a built-in water system for wetting the fine dust generated by the drill and a 28-ft mast that can be raised or lowered in less than 2 min. Two men drill an average of 600 ft of 7¾-in hole per shift and have drilled as much as 100 ft per hour in addition to loading explosives. Bit life averages 4,000 ft of hole (*Coal Age*, June, 1957, p 60).

ROTARY PERCUSSION DRILLING—A down-the-hole rotary percussion drill, working three shifts in an anthracite pit, sinks enough holes in hard rock to keep pace with 6- and 8-yd draglines. Water check valves between two of the drill rods prevent entry of water and dirt into the hammer if the compressed-air supply is interrupted in the drilling of wet holes (*Coal Age*, May, 1958, p 114).

VERTICAL AUGERING — Vertical augering machines have been improved to the point where they can drill a 9-in hole in coarse-grained sandstone to a depth of 100 ft. Operating through a multispeed transmission, drill rotation can be regulated according to the toughness of the rock. Up to 600 ft of hole per shift can be drilled with this machine.

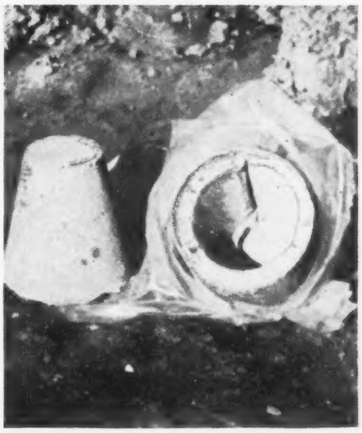
At one Ohio mine two crews use auger-type machines to sink an average of 600 ft of hole each per shift in sandstone overburden. At another Ohio mine two men drill 400 ft of 8-in hole per shift and also help charge holes with AN-oil mixture at the end of the shift.

HORIZONTAL AUGERING—The horizontal sidewall drill remains a favorite for special applications and where the cover is comparatively thin, or where tough rock lies close to the coal. In some cases they are used effectively for two-level drilling in thicker cover. Special adjustable-level hydraulically powered sidewall units can be used effectively to drill near a strata whose position over the coal varies up and down. They also have the advantage of easy leveling in an uneven pit. Most of the units in service today are either truck mounted or are towed on small trailers.

HORIZONTAL ROTARY DRILLING—To meet the need for more efficient equipment to drill hard rock fast, several horizontal rotary dry-type overburden drills are now available. The newest machine has two independently controlled adjustable drill masts on 22-ft centers. It can drill two 6¾-in to 12-in holes to a depth of 90 ft. Each drill mast has its own set of hydraulic positioning jacks and hydraulic controls in an air-conditioned operator's cab. By adjusting the three jacks on a mast the operator can start a hole at any level from 2 to 8 ft above the ground. He can angle either mast from 10 deg below the horizontal to 15 deg above. At a Missouri mine it has demonstrated its ability to drill over 2,000 ft of 6¾-in hole per shift (*Coal Age*, January, 1961, p 78).

A single mast unit in service at an Indiana mine drills a 9-in hole 48 ft deep without adding drill sections. Penetration is 50 in per minute. Working one full and one part shift six days a week, it drills enough holes to prepare overburden for round-the-clock operation, seven days a week, of a 40-cu yd shovel. In the best single shift, 816 ft of 9-in hole was drilled by one man. Clean, smooth holes make possible loading of explosives with diameters only slightly less than the hole. Holes are reported to be straight and not to drift in the direction of rotation as auger-drilled holes do. Drill cuttings, as with vertical dry-type machines, make excellent stemming material.

SPECIAL DRILLS—Where a major portion of the overburden is soft enough to be dug without previous shooting there often is the need for special units to drill a thin layer of rock over the coal, or to drill a hard rock band between two or more coal



TAMPING PLUGS, enclosed in plastic bags, reduce charging time per hole by one man-hour. Two sections of plug are shown at right.

SPECIAL BOOSTER is designed to produce high heat with good detonation velocity.

beds. A three-man crew at a western Kentucky mine uses a four-unit jumbo on a tractor to sink 2-in holes on 6-ft centers in a 4-ft layer of limestone. In average work four holes are drilled in 4 min (*Coal Age*, October, 1956, p 65).

Other machines available for drilling thin layers include single air-powered drills on hand-pulled wagons and one or two drills on the rear of a tractor.

BLASTING MEDIUMS — Blasting mediums in use today include various types of high explosives; liquid oxygen; and newly developed lower-cost ammonium-nitrate-type blasting agents.

Many of the explosive manufacturers now are producing ammonium-nitrate-type or similar blasting agents. Some of these agents include the following: (1) Nitro-carbonitrate which contains technical-grade ammonium nitrate instead of commercial grade. It is not cap-sensitive, and therefore a primer must be used to set off. Speed is about 11,500 fps; (2) Unimite and (3) Methanite which contain technical-grade ammonium nitrate, coal dust and nitromethane. The nitromethane acts as a sensitizer for the ammonium nitrate and under certain conditions it is not necessary to use a primer. Speed is about 13,000 fps.

Significant improvements in manufacturing techniques have resulted in lower prices for liquid-oxygen explosives. Having a speed of 17,000 fps, this explosive has been very useful in breaking high banks containing massive sandstone.

NITRATE-OIL MIXING—Ammonium nitrate-oil mixes continue to lead as a breaking medium for overburden. Despite the low cost of the mixture, operators are stressing more and more the need for better mixing and packaging, along with better handling in the pit.

Not only are operators becoming more interested in better mixing and handling, they also are becoming more particular in the quality of the nitrate they are buying. For example, such properties as grain size, porosity, particle strength and moisture content are being studied more closely. And research is under way to develop better mixtures of oil and nitrate.

THREE STRANDS of 175-grain detonating fuse serve as primer for nitrate-oil mixture packaged in double bags.

Multiple primers increase the apparent velocity of detonation. By starting the chemical reaction at several points the time required for a charged hole to detonate is reduced. An added feature of multiple detonation is the greater chance for setting off the charge.

Most companies making their own blasting agent use either prilled or grained ammonium nitrate with No. 2 fuel oil. Approximately 4 qt of oil are added to each 100 lb of ammonium nitrate. Many of the larger companies have their own mixing plants where ingredients can be metered as they flow to a mechanical mixer. Some companies use the product immediately after it is packaged while others perfer to let the mixture season before using it. The seasoning period varies from several hours to several days.

Other producers prefer to mix the nitrate and oil at the hole site. Oil is poured over opened bags at each hole and then left to percolate down through the ammonium nitrate for a short period before holes are charged.

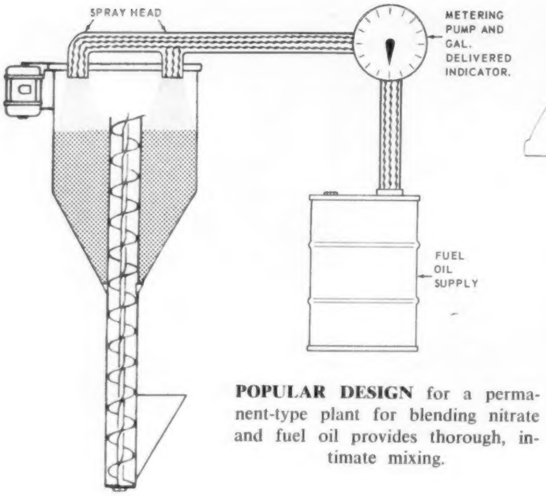
Some operators are using a combination of denser grained nitrate-oil for loading the bottom of holes and prilled nitrate-oil for the upper portion. This method of loading concentrates the blasting agent where it is needed most and makes possible wider hole spacing. There is a corresponding saving in drilling requirements.

Considerable research and development in the use of slurry-type blasting agents has been carried out recently. Slurries are non-cap sesitive, water resistant, have high density and are good in wet conditions.

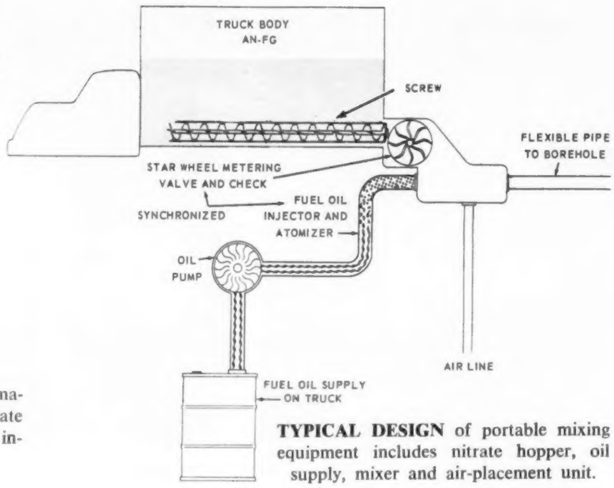
One new slurry product is essentially a mixture of ammoniun nitrate, sodium nitrate, high-explosive sensitizer and water. It has a density of about 1.5 and a rate of detonation of approximately 17,000 fps. The slurry may be used in the polyethylene bag or poured into the hole. Charges of up to 300 lb should be primed with 5 lb of 40, 60 or 75% gelatin or 1 lb of special cast primer. Slurries vary in cost but are usually more expensive than waterproofed packaged ammonium nitrate-oil mixtures.

PRIMING—Research and field testing have shown that prilled ammonium nitrate-oil mixtures react differently with different priming systems. Tests show that the primer used can give three types of reaction: (1) brisance, or sharp cracking; (2) large volume of gas; and (3) brisance and gas volume.

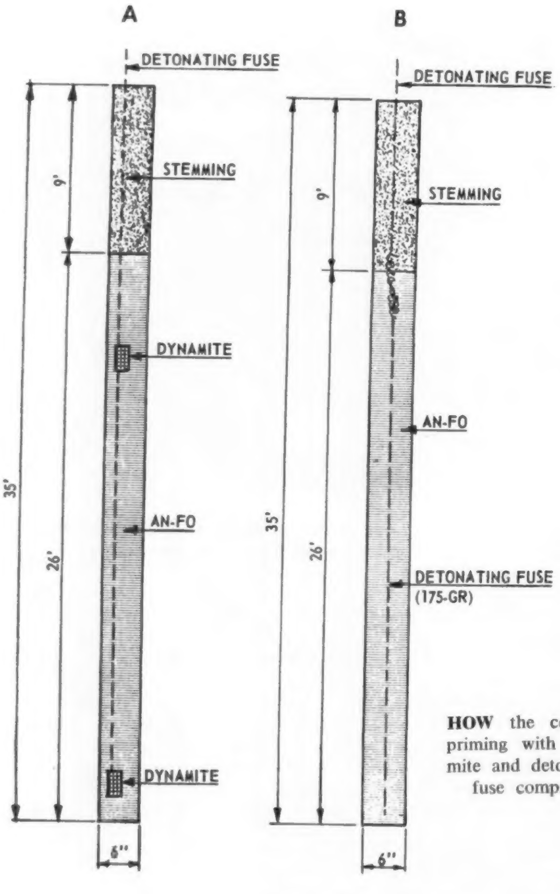
Dynamite, with the exception of high velocity gels, gives primarily more gas volume. It is a good primer for a mine that



POPULAR DESIGN for a permanent-type plant for blending nitrate and fuel oil provides thorough, intimate mixing.



TYPICAL DESIGN of portable mixing equipment includes nitrate hopper, oil supply, mixer and air-placement unit.



HOW the cost of priming with dynamite and detonating fuse compare.

Cost with Dynamite Primer (A)

250 lb AN at $0.04/lb	$10.00
35 ft 50-grain det. fuse at $0.032/ft	1.12
2—2x8 sticks of 60-75% dynamite, approximately $0.36 each	.72
2.5 gal No. 2 fuel oil at $0.10/gal	.25
Total	$12.09

Cost with Detonating Fuse (B)

250 lb AN at $0.04/lb	$10.00
20 ft 150-175-grain det. fuse average at $0.057/ft	1.14
15 ft 50-grain det. fuse at $0.032/ft	.48
2.5 gal No. 2 fuel oil at $0.10/gal	.25
Total	$11.87

Spencer Chemical Co. data

needs heave and throw. Detonating cord produces brisance and, therefore, is good in hard rock. Special cast boosters incorporate high velocity and high temperature to combine gas production and brisance to work effectively in either soft or hard materials.

NON-SENSITIVE PRIMERS — Non-nitroglycerine primers for use with make-your-own blasting agents are growing in favor. These primers are popular because they cannot be detonated if a shovel digs into a misfire. Danger to personnel and equipment from this hazard thus is eliminated. A popular unit combining safety and economy is a 5-lb primer packaged in a polyethylene bag.

BUILT-IN PRIMERS—Specially packaged ammonium nitrate with built-in primer simplifies loading of horizontal blastholes while maintaining the advantage of low cost. These packages commonly come in 20- and 25-lb cylindrical cartridges, 4 or 5 in in diameter.

LOADING HORIZONTAL HOLES—When the overburden is not too thick or is not exceptionally hard, a single row of properly charged horizontal holes usually is sufficient to break the overburden. The rule of thumb in blasting with a single row of horizontal holes is to space them so that the resistance of the material above the holes will roughly equal the resistance of the material between the holes.

If the horizontal holes are placed too close together, the explosives will have a tendency to shear between holes rather than exert force upward to break the rock. As the thickness of the overburden increases, it becomes necessary to increase the hole diameter to maintain the proper concentration of explosives and not get shearing. In thicker cover it is possible to use angled holes or a combination of horizontal and vertical holes.

BLOW CHARGING — Greater loading density and a significant saving in time and effort in charging horizontal blast-holes are two major benefits resulting from the use of a blow-charging machine. Experiments at an Ohio mine show that an 80-lb bag of ammonium nitrate can be mixed with 1 gal of fuel oil in 20 sec and then blown into a horizontal hole in 10 sec (*Coal Age*, November, 1958, p 86).

At a West Virginia operation pre-oiled ammonium nitrate, half prilled and half granular is purchased in 80-lb bags and blown into horizontal holes by a truck-mounted unit. It takes about 3 min to blow 240 lb of nitrate into a hole. Each hole is primed full length of the charge with 1½ x-12-in high-velocity gelatin inserted in connected sections of tubes.

MECHANICAL TAMPING—Another device designed to reduce human effort in loading and tamping horizontal holes is the load-tamp machine. With the aid of this unit, one man in four days, single shift, does what it took two men five and six days to do. Greater flexibility in pit operations is an added benefit since blastholes now can be loaded after the seam is taken out to the highwall.

The operator's duties consist of placing the explosives and tamping bags in the collar of the hole. Using prefilled tamping bags, one man has loaded and tamped a maximum of 28 holes in a shift.

TAMPING PLUGS—By using two-piece tamping plugs instead of bagged drill cuttings for stemming horizontal holes, a Kentucky company saves about one man-hour per hole in stemming time.

The tamping plugs are individually packed in polyethylene bags to prevent separation of the solid plug and the expansion cone. In tamping a hole, a worker pushes a plug against the blasting agent and then strikes it solidly with the tamping stick, thus forcing the wedge ahead and splitting the expansion cone. This action seats the tamping plug solidly in the hole (*Coal Age*, February, 1961, p 76).

BULK HANDLING — Bulk purchasing and handling provides considerable saving in the cost of ammonium nitrate. For instance, the cost per ton of bulk nitrate is $4 to $6 less than the bagged price. Furthermore, in some sections of the country an additional saving of $1 to $2 per ton in freight charges can be realized by purchasing nitrate in 50-ton minimum quantities. A third saving, once a user has converted to the bulk product, is the manpower reduction in loading and handling the bulk nitrate. The minimum consumption that would justify conversion to bulk handling is estimated at 700 tons per year.

Bulk handling procedures are cutting handling costs of make-your-own blasting agents at several mines. One bulk loader for vertical holes consists of a storage hopper, hoist, air compressor, oil-storage tank and a measuring dispenser, all mounted on a flatbed truck which is loaded from a 36-ton bulk-supply bin.

An air motor run by the compressor and a winch in the fore end of the truck is used for tilting the hopper to enable the nitrate to gravity feed into a 300-lb measuring container at the back end of the truck. The nitrate is admitted to the borehole by opening a butterfly valve in a 6-in drain pipe.

Actuation of the manually operated valve also operates a snap valve on an oil line through a mechanical linkage to spray a metered quantity of oil through a nozzle in the drain pipe onto the nitrate as it falls through the pipe. A drill hole can be loaded with 200 to 300 lb of mixture in 20 sec.

Another company developed a mechanical mixing system for bulk loading vertical holes. The proper mixture of oil and nitrate is obtained by controlling the gravity flow of nitrate out of a hopper and by metering oil as it is sprayed into the falling nitrate stream.

A third company solved the handling problem by developing an air-loading procedure for charging holes angled upward at 45 deg. Ammonium nitrate is poured into the storage hopper of the loading device, from which it is admitted to an air tank. As air at 35 psi moves the nitrate through a rubber hose, fuel oil is forced by air through an adjacent hose. The two meet at a junction point and flow through a pipe into the drillhole at the rate of 100 lb in 10 sec (*Coal Age*, November, 1958, p 105).

CHARGING WET HOLES—Two problems to overcome in charging wet holes with ammonium-nitrate-type blasting agents are: (1) protecting the mixture from moisture and (2) obtaining a mixture of nitrate with the proper density so it will sink in the water.

An Ohio company solved these two problems by packaging the blasting agent in burlap bags with a polyethylene liner and using ground granules with prills to get a density of 1.16.

The mixture for wet holes, mechanically mixed in 2,000-lb lots at the companys plant, consists of 1,360 lb of prilled ammonium nitrate with a density of 0.95, 640 lb of ground ammonium nitrate granules and 85 lb of No. 2 fuel oil. Bags are filled at the plant by hand vibrating.

One-third pound of cast PETN is used as primer for each 192 lb of the ammonium nitrate mixture. It is placed inside a bag of nitrate mixture and connected to the 60-grain detonating-fuse trunk line by a short section of detonating fuse.

Several companies have found it profitable to shoot water from wet holes with explosives. For example, one company uses approximately 1 lb of PETN with cap per 5 ft of water. All holes to be shot are prepared before any one hole is shot, then the holes are fired separately.

Each hole is inspected for depth of new water before loading. If no more than 6 in of water returns to the hole, the oil-nitrate mixture is poured into the hole. If more than 6 in of water returns, cartridge powder is used up to a level above the displaced water, and then ammonium nitrate is added in the remainder of the hole. A second operation uses 4 to 8 lb of 60% dynamite per hole to blow out water.

DELAY SHOOTING — Delay shooting usually will enable explosives to do a better job. At many mines milli-second delays have been used successfully to get better fragmentation and at the same time reduce concussion in the surrounding area. Reduction of vibration is especially important where stripping is being done near populated areas.

As overburden becomes thicker, the problem of vibration and shock becomes greater because the thicker rock requires more explosives. In recent years, the MS-delay connector has become a valuable tool in reducing vibration—in many instances to about 25% of that with the usual shot.

The MS connector essentially is a piece of detonating fuse with a milli-second delay built into the center. Benefits from the connectors include setting off a greater number of holes per shot with less vibration, and elimination of the hazard involved in loading a cased hole where it is necessary to charge from the drilling machine through the casing and then pull the casing up over the shunted cap wires. During this operation there is always the hazard of stray currents or a short circuit that might ground through a damaged cap wire, setting off the charge. With detonating fuse, no cap is used until this operation is completed and the machine has moved away.

A further advantage includes a 15% speedup in the detonation of the explosive with a reduction in the requirements. Fragmentation is as good and probably better with the reduced charge. Digging into misfires is not likely to result in an accidental explosion since caps are not used.

While many applications have resulted from the use of detonating fuse and MS connectors, at least one serious disadvantage of the combination is the noise and concussion caused by the detonation of the unconfined trunk line. When the shooting operation is close to populated areas, this condition presents a problem. At one mine where the elimination of noise is highly desirable, detonating fuse is used to fire the primers. Holes are shot in groups of 11, using a single instantaneous electric blasting cap and delay caps in series 1 through 10. Only a single shovelful of dirt is required at each hole to effectively cover the few inches of exposed detonating fuse and the blasting cap.

BUFFER SHOOTING—There are certain advantages to shooting against a buffer where vertical drilling is practiced. Large chunks of rock, sometimes produced when shooting against an open face are eliminated. The long toe that cannot be shot at all is eliminated. The drill never is required to work close to the highwall in an attempt to shoot a toe. A uniform pattern of drilling can be maintained because regardless of how crooked a pit is when first opened, adjustments can be made to produce a straight pit with a minimum of trouble.

Once a sufficient buffer is established to put the drill well ahead of the stripping machine, other benefits are possible. For example, in periods of dry weather the drill can be worked in areas of the highwall that would be very muddy in wet weather. And in wet weather the drill can be worked on ridges or high spots. If advance preparation of the highwall is needed for moving the drill, felled timber and brush can be pushed on to the buffer area and require no further rehandling prior to final disposal.

The operator of the stripping unit can widen or narrow the pit to take full advantage of the machine in the spoil area available and without interfering with the drilling and shooting. Better slopes of the highwall can be made, thereby eliminating many slides that occur when there is a high, cracked over-hang.

IMPACT BREAKING — At a western Kentucky mine recovering two 5-ft seams of coal separated by 11 ft of rock an unusual

Analysis of operating costs at a stripping operation

1. Fixed Factors

Dragline:	Total operating cost, \$22 per hr. Working capacity 4.5 cu yd, 219 cu yd per hr, efficiency 60%, dumping radius 135 ft, maximum overburden height less than 100 ft.
Overburden:	10,000 cu yd volume per shot, ratio 10:1, height 60 ft (40 SS, 20 SH).
Coal:	Thickness 6 ft. Hauled by contract trucks.
Drilling:	5-in holes, 60 ft deep, at \$.30 per ft.
Blasting:	AN-FO blasting agent at \$4.00 per cwt primed with 75% gelatin.

2. Present Operations (Breaking with explosives)

Overburden volume 10,000 cu yd loaded with 2,500 lb AN prills field mixed, powder factor 4:1. Shooting five 5-in holes, 60 ft deep, 30-ft spacing on 30-ft burden. Dragline works off shot bank, casting across 75-ft pit to spoil.

2a. Present Costs (1000 tons/day)

			Cost per Cu Yd
Drilling:	300 ft × \$ 0.30 per ft	= \$ 90.00	\$0.009
Blasting:	2,500 lb × 4.00 per cwt	= 100.00	0.010
Dragline:	45 hr × 22.00 per hr	= 990.00	0.099
Total stripping costs		\$1,180.00	\$0.118

3. Proposed Operations (Casting with Explosives)

Overburden volume 10,000 cu yd, loaded with 10,000 lb of AN prills field mixed, powder factor 1:1. Shooting twenty 5-in holes, 60 ft deep, 15-ft burden on 15-ft spacing. Dragline works on spoil pile. 40% moved by explosives.

3a. Probable Costs

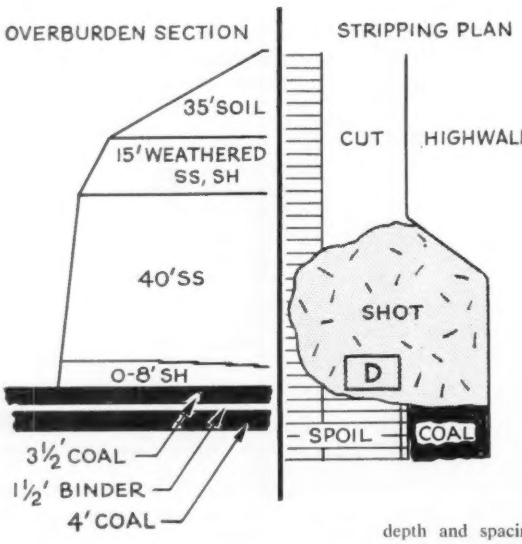
			Per Cu Yd
Drilling:	1,200 ft × \$0.30 per ft	= \$ 360.00	\$0.036
Blasting:	10,000 lb × 4.00 per cwt	= 400.00	0.040
Dragline:	27 hr × 15.00 per hr	= 594.00	0.059
Total stripping costs		\$1,354.00	\$0.135

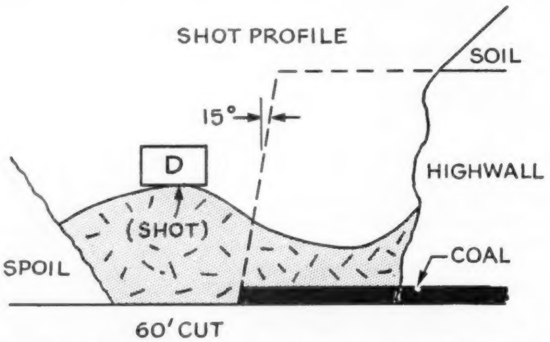
4. Comparisons

Present Operations:	It takes 45 hr to strip 10,000 cu yds at daily strip rate of 1,818 cu yd per 8-hr shift to maintain production rate of 1,000 tpd. Stripping cost per day is \$214.50 which, divided by 1,000 tpd, is equivalent to \$0.214 per ton.
Proposed Operations:	It will take only 27 hr to strip 10,000 cu yd at daily strip rate of 2,962 cu yd per 8-hr shift. This strip rate is 63% higher, uncovers 63% more coal per day. Thus, stripping cost per day, \$401.00, divided by increased tonnage per day (1,630 tpd) is equivalent to \$0.245 per ton.

5. Conclusions

1. Total cost per ton is only \$0.031 more.
2. Stripping capacity is increased 68%—from 219 to 370 cu yd per hr.
3. Coal production is increased 63% —from 1,000 to 1,630 tpd.
4. No capital expenditures are required.





PLAN AND PROFILE of a typical application of explosives to overburden casting shows a minimum of material to be handled by excavating machines. Section at left shows types of overburden.

method of breaking the interval is used. The outer 25 ft of a 45-ft cut is broken with a 17-ton drop ball. The breaking medium actually is a steel billet 8 ft long, 60 in wide and 30 in thick. It is hoisted 50 ft into the air by a diesel-electric shovel converted to a crane and dropped on 6-ft centers. Cycle time is 45 sec. Excellent fragmentation is reported at a considerable saving over drilling and blasting.

BLASTING RECORDS — Good records should be kept for all blasts, including depth and spacing of holes, quantity and distribution of explosives per hole, type and thickness of overburden, feet of drilling, and cubic yards of material broken each day. When a satisfactory plan for shooting is worked out it should be adhered to until conditions change.

One company has developed an electric device that automatically records the depth of the blasthole as it is drilled. When a change of strata or a significant change in hardness occurs in the rock, it is reflected in a variation in drilling pressure. The drill operator notes depth on the indicator, as well as pressure, and records both in a log book. The record for each hole is given to the blaster to serve as a guide in charging the holes. The blaster can look at the hole log, tell how tough the rock is and then determine how much explosives will have to be used to get the best results. Drill-pressure indicators also show changes in the hardness of the strata and thus provide additional data for judging placement and quantity of charges.

An Ohio operator employs a blasting chart as a guide in charging holes with nitrate-oil mixture. The chart shows the proper charge for varying hole depths and centers to get the desired concentration of blasting agent.

Checklist Of Strip Mine Conditions

1. Favoring Explosives Casting:
- (a) deep, hard, overburden requiring extensive shooting
- (b) dumping radius of primary stripping unit less than 150 ft
- (c) narrow, steep, cuts—60 to 100 ft wide
- (d) undercapacity of primary stripping unit
- (e) overcapacity of coal mining unit
- (f) ability to use least expensive AN-FO explosive

2. Unfavorable for Explosives Casting:
- (a) overburden shallow and easily excavated
- (b) cuts more than 100 ft wide
- (c) poor conditions (water, etc.) for bulk AN-FO
- (d) possible need to run haulage road past stripping unit

As a result of using the chart, consumption of ammonium nitrate is less and rock fragmentation is as good or better than before (*Coal Age*, January, 1960, p 83).

EXPLOSIVES CASTING—Some strip operators are finding it profitable to move overburden with explosives alone. In this method, large volumes of low-cost ammonium nitrate-oil mixtures are loaded into medium-diameter drillholes in a ratio of more than 1 lb of mixture per cubic yard of overburden and detonated with millisecond delay caps. When the shot is fired, a large part of the overburden is blasted into the pit away from the highwall and up on the spoil pile where it attains a favorable angle of repose. Some mines report that 30 to 50% of their overburden is moved with explosives.

Dragline operators benefit because instead of working off the shot bank, they may be positioned on the spoil pile. This advantage practically eliminates the need for recasting. It also reduces the time spent by bulldozers in smoothing a dragline walking bench (*Coal Age*, March, 1961, p 78).

Stripping

REMOVING OVERBURDEN as economically as possible is the aim with any stripping machine. To move the maximum volume of material, a machine not only must operate continuously but also must make each motion perform useful work.

SHOVELS AND DRAGLINES—Shovels are available in a wide range of designs and capacities to meet most stripping conditions. For example, a 3-cu yd shovel with a 28-ft boom and 20-ft dipper handle can cut to a 32-ft height. A 45-yd shovel with a 120 ft boom and 79-ft dipper handle can cut to a height of 107 ft. The 60-yd shovel which went into service in 1956 has a 150-ft boom and can pile spoil 97 ft high. The 70-yd shovel which began stripping in 1957 has a 140-ft boom and a maximum dumping height of 96 ft 6 in.

The giant 115-cu yd shovel now under construction will have a reach of over 460 ft and will be powered by 50 motors, ranging from ¼ to 3,000 hp. It will remove 3,000,000 cu yd of overburden per month.

An improved long-range electric shovel incorporates a new-type control using solid state components in place of rotating units or electronic tubes. Since there are no moving parts, control life is expected to be unlimited. The control also is designed to provide instantaneous response with higher bail pull at any selected speed (*Coal Age*, February, 1961, p 76).

A new twin-engine diesel shovel makes possible faster cycles with less operator fatigue. The unit enables the operator to perform several functions simultaneously and thus increase operating speeds. Faster operating cycles and greatly reduced maintenance are added benefits (*Coal Age*, July, 1960, p 97).

Draglines also are available in a wide range of sizes to meet varying conditions. A 2¾-yd dragline with a 110-ft boom can dig to a depth of 58 ft and spoil to height of 49 ft above the bottom of the bench on which it is working. A 35-yd unit with a 220-ft boom can dig to a depth of 94 ft and pile spoil 98 ft high above the tub.

Dragline capacity reached a record high with announcement of the 85-cu yd machine now under construction. It will have a 275-ft boom, 248-ft dumping radius and a 143-ft dumping height. Its working weight will be 10,675,000 lb (*Coal Age*, April, 1961, p 26).

Big shovels in the 33- to 70-yd range usually work to a maximum of 70 to 80 ft of cover. Removal of overburden between 9 and 50 ft thick by a 45-yd shovel costs about 45% of what it would cost to do the same job with an 8-yd shovel; in overburden between 9 to 90 ft, about 77% of the cost with an 8-yd shovel and in overburden between 50 and 80 ft, about 25% more than an 8-yd shovel working in a bank 50 ft high. Big shovels also recover coal that would be left by smaller shovels or would have to be augered or deep mined. But the area to be stripped must contain enough coal to warrant the capital expenditure for a big shovel.

Flat coal seams and steep slopes cause overburden thickness to increase rapidly as successive cuts advance into the hillside. To meet these difficult conditions, the large walking dragline is most useful because of its long dumping range. The stripping life is increased in proportion to the dumping range of the dragline, and maneuverability of the unit is advantageous in working sharp angles and inside curves. The disadvantage is that it must have a suitable base and this is sometimes difficult to provide in rocky overburden. This factor must be considered in choosing between a dragline and shovel.

BULLDOZER-SHOVEL STRIPPING—A possible combination for stripping up to 35 ft of softer material is the small shovel and the bulldozer. With this type of setup the bulldozer works across the outcrop and takes off 10 to 12 ft of loose material—sometimes up to 20 ft. The shovel is used to remove the more solid material down to the top of the coal.

At an operation in Pennsylvania two big, powerful bulldozers are teamed with a diesel-powered 2-cu yd shovel and a 4-cu yd diesel dragline to move up to 60 ft of cover. Each dozer works with one of the strip machines in a separate pit, two shifts per day. The bulldozers not only cut down a portion of the bank but also push a great deal of the material into the pit where the stripping units can handle it easier. They also push a large portion of the material in the spoil to a point beyond the range of the stripping units.

After a sufficient area of coal is uncovered, the shovel doubles as a coal-loading unit while the bulldozer continues to remove the top layer of cover or performs utility work. The shovel-bulldozer setup is not designed for high output but can be used effectively where cover is relatively soft and a large capital expenditure is not feasible.

Cutting down 70% of the overburden and leveling shovel spoil, a twin-engine bulldozer provides flexibility of operation at a Pennsylvania mine recovering 40-in coal. A diesel-powered shovel handles the lower part of the overburden (*Coal Age*, November, 1959, p 98).

Bulldozers are teamed with a shovel or dragline to remove overburden in two-seam stripping in hilly terrain in West Virginia (*Coal Age*, April, 1959, p 85).

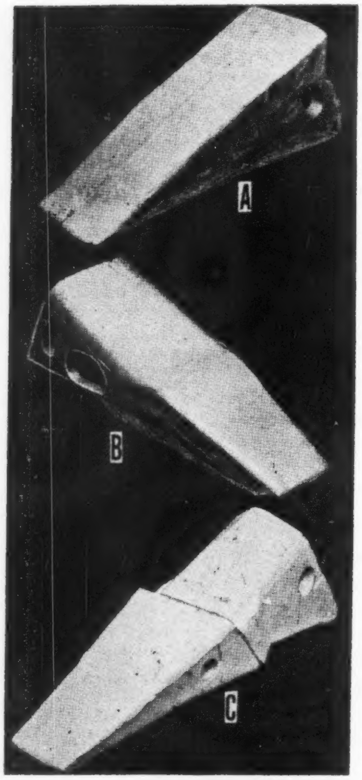
At a Pennsylvania mine operating in 36-in coal, a bulldozer with a hydraulic tilt blade takes the initial cut to within a few feet of the solid sandstone. A 6-yd diesel-powered dragline handles the remainder (*Coal Age*, September, 1959, p 106).

A bulldozer plays an important role at an Ohio mine recovering 30-in coal under 60 ft of shale and limestone. The unit cuts down 12 ft of shale and makes a level bench for a 5-yd shovel which removes the remaining overburden. After stripping is completed to a 60-ft highwall, the bulldozer levels spoil for seeding (*Coal Age*, July, 1960, p 96).

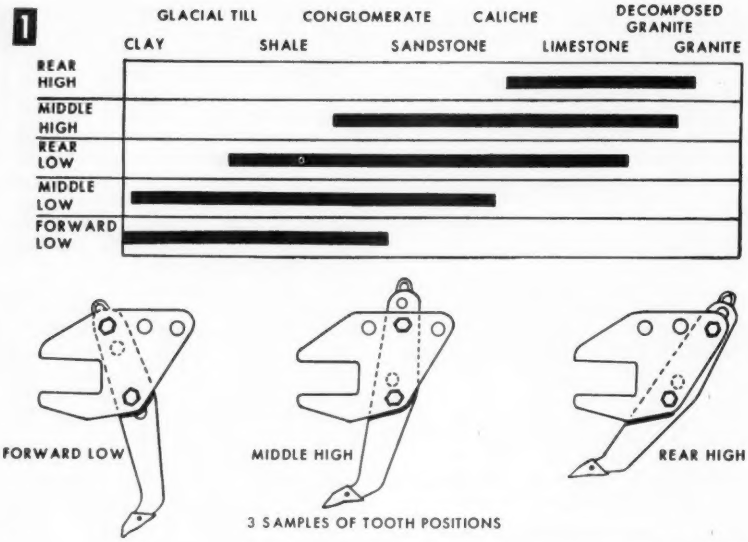
BULLDOZER STRIPPING—As a result of more speed and power being built into today's bulldozers, they are being used more and more as stripping units. Working in pairs or in conjunction with other equipment, they are effective in moving overburden that normally requires little or no shooting.

Where stripping is assigned to bulldozers alone, a minimum of two should work together. For efficient material handling, an average of not more than 35 ft of cover should be moved and the terrain should be gently rolling or hilly to permit easier movement of overburden. Pushing should be 90 deg with the outcrop after the initial cut is made along the outcrop and the bulldozers should work together, one following the other and slightly overlapping the path of the leading unit to pick up side spillage.

After the pit is filled sufficiently, the dozers should start pushing to the main spoil area away from the highwall. As succeeding cuts are made and the highwall gets steeper, it will be necessary for the dozers to rehandle as much as 20% of the material. To establish the highwall, the bulldozers should cut parallel to the outcrop and dig down to the coal. If hard material is met, it should be either drilled and shot or ripped fine enough so that the bulldozers can move it easily.



TIP USES—A, for very hard material; B, for fracturing and penetration; and C, for very abrasive conditions.



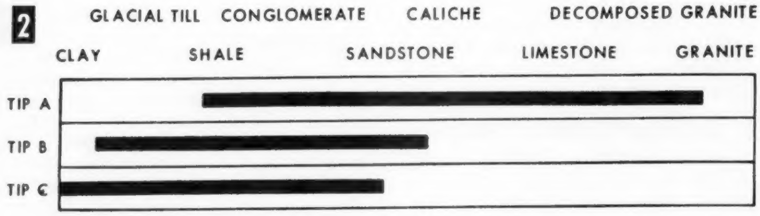


CHART I summarizes the settings of a 5-position clevis, according to the hardness of the material being ripped. Chart II is a guide to the type of tip to use in different materials.

RIPPING OVERBURDEN—The development of the hydraulically operated ripper mounted on the rear of a large bulldozer has increased the range of the scraper. The shales and soft rock that previously resisted loading by scrapers or ripping with old-type rippers or rooter are now successfully loosened. In one pass the hydraulic unit with three arms spaced at 53 in can loosen a total width of 9 ft to a depth of 12 in.

Ripping procedures vary with the stripping unit. For example, for bulldozing a minimum of passes is made to give the lowest cost. More passes must be made for scraper loading.

In general, rip as deeply as possible. Experimenting with ripping angles and depths is advisable. For scraper loading, rip in the same direction as loading.

Ripping cost compared with blasting cost must be favorable to justify its use. Under typical conditions, a 320-hp tractor with ripper can produce 300 to 600 cu yd per hour.

SCRAPER STRIPPING—Conditions may change after a stripping unit has been purchased and it may be desirable to go to a higher bank, but the available shovel or dragline may not be able to handle the overburden in one pass. Consequently, rehandling or two passes are needed. Or the unforeseen problem of a shortage of spoil area may develop and partial haulage may be necessary. Under these conditions the high-speed rubber-tired tractor-scraper has gained acceptance as an efficient auxiliary machine to move the top portion. Once loaded, the unit can haul spoil several hundred feet at little added cost. If the overburden is compacted, it is good practice to supplement the scraper units with a ripper that can be taken over the area ahead of the scrapers to break up the ground.

Scrapers, push-loaded by big bulldozers, slice off overburden in 25-cu yd bites at an eastern Ohio operation. Six units remove 1,800 to 2,000 cu yd per hour while working banks 50 to 60 ft high. Ripper-equipped tractors precede the scrapers to break the friable sandstone for the scrapers (*Coal Age*, December, 1958, p 110).

Scrapers, push loaded by big bulldozers, remove overburden on a 30- to 35-ft seam at a Wyoming mine. The stripping ratio is about 1:1 and the maximum will be 2:1 (*Coal Age*, October, 1959, p 74).

Tractor-scraper units also can be used to make an opening cut and working bench for a dragline. The number of tractor-scrapers needed for the job depends on how much of the total cover can be moved by the scraper and how much overburden must be moved to uncover the coal needed each day. For example, five tractor-scraper units aided by a rooter have removed 30 to 35 ft of cover at an operation working to a 75-ft highwall and producing 1,700 tpd of strip coal. Shovels remove the lower portion of the overburden.

A worthwhile advantage of the scraper method of handling spoil is that little extra work is necessary where backfilling and leveling are required.

In some deep anthracite pits where available draglines cannot handle overburden in one pass, the highspeed scraper has been well accepted as a primary unit in removing the top layer of overburden. Thus the dragline burden is eased.

A push-loaded scraper will load faster and will carry greater payloads because the load is heaped better and packed tighter. To get the most from scrapers, the loading area should be planned so that the units load on a down grade; haul roads should be well maintained; and the dumping area kept in good condition so the load can be released while traveling at a fair rate of speed.

Good preventive maintenance practices to follow in scraper operation include keeping good cutting edges on the scraper at all times; and holding the apron at proper height while loading to avoid damage or distortion. A misshaped apron permits load leakage on to the haul road with possible resultant tire damage. A light channel welded across the top of the scraper front end will prevent the sides from bulging and will not hinder loading.

BOX-CUTTING—Opening a pit by box-cutting involves digging down to the coal and then working straight ahead to the limit of the property. By exercising care in opening a new strip pit along the property line in flat or gently rolling land it is possible to recover practically all of the coal in the tract. In some instances where a shovel or dragline is used to open a new tract along an adjoining property the first-

cut spoil is placed on the surface next to the property line. Stripping then advances into the tract and the coal along the property line and under the first-cut spoil is left in place. Some operators do not consider it economically possible to rehandle spoil from the opening box cut and the regular material over the coal. As a result, the strip of coal along the property is never recovered. If a strip of coal 75 ft wide, 4 ft thick and 3,000 ft long is left in place along the property line, the loss will be about 37,000 tons.

AUXILIARY MACHINES—Consider the possibility of using auxiliary earth-moving equipment, such as scrapers and bulldozers to move the spoil from the opening box cut. It might be possible to start at the property line and cut down 10 to 20 ft of material with scrapers and spread it in a thin layer 4 to 5 ft thick over the surface where it can be easily handled in subsequent cuts. The scrapers could open the area by making a cut 100 to 200 ft wide along the property line. Exact width of cut can be laid out to fit into the overall plan for the regular stripping machine. It may be desirable for the auxiliary machine to cut down an area that is two or more times the width of the cut that will be taken by the shovel or dragline.

If the resulting pile is too high to be moved efficiently by the shovel or dragline when the second cut is made, a bulldozer can be teamed with it to level and spread the material in the spoil area. Or if the material is broken finely enough, it also might be possible to use scrapers effectively in the spoil area. The cost of rehandling the first-cut spoil should be weighed against the value of the coal left in place and the effect on the cost of handling overburden over the life of the mine.

STRIPPING THICK COVER—Where extra thick cover is constantly present the big dragline is the most popular machine. However, the successful application of the 60- and 70-yd units shows that shovels can not be counted out in the thicker cover.

If only one machine is desired for stripping under consistently thick cover, the dragline usually gets the nod. Improved electrical controls and bigger motors have made it possible for the drags to work to higher banks and move more cover per hour. The result is more material moved at no greater cost than when working to lower banks. Where shovels would be working at extreme range, rehandling materials, or working in two lifts the dragline definitely offers advantages.

TANDEM STRIPPING—Many combinations of machines are removing over-burden efficiently. For example, a shovel may be teamed with a dragline in a tandem operation. In this type of set-up, the drag works ahead, taking the upper section of the overburden and leaving the remainder for the shovel. The percentage of material to be handled by each unit depends on the capacity of each and the stripping conditions.

Various other combinations are being used in tandem operations. Where there is a fairly thick layer of soft material at the surface, tractor-scrapers and bulldozers can work on the highwall and cut down a sizable portion of the overburden. Auxiliary equipment also can be used effectively on the spoil pile to permit stripping units to work to higher banks. Where auxiliary units work on the spoil bank, they frequently do a great deal of leveling so that final reclamation or backfilling is not too costly.

MULTIPLE-SEAM STRIPPING — Two or more seams close together frequently can be mined profitably where one alone would not be profitable. The choice of equipment and the mining method depends on the dip and thickness of the coal; the topography of the land; and the type of rock above and between the coal beds.

In anthracite mining, multiple seam stripping usually is on the pitch. Overburden may be moved by any of the standard types of stripping equipment, including draglines, shovels and draglines, or shovels alone. Spoil haulage is common practice.

Where there are flat or nearly flat seams, overburden has been moved by a specially designed shovel, two draglines plus an auxiliary shovel, or a shovel and dragline. The choice of equipment in each case was made to get the best results under the conditions.

The specially designed shovel stripped two seams simultaneously from one position in gently rolling country. Both seams were thin and are separated by 16½ ft of rock. Working on the lower seam, the shovel uncovered a 50-ft strip on each level while working to banks up to 60 ft above the upper seam.

The two draglines and auxiliary shovel were used in flexible setup in gently rolling country to mine two seams separated by 3 to 10 ft of limestone. Where banks ranged between 50 to 70 ft in thickness, the two draglines worked in tandem, and where cover is thinner they worked separately. The limestone interval between the two seams was drilled with percussion units and the broken material cast to the spoil area by the coal shovel in the off shift.

The shovel and dragline were teamed to mine two seams separated by about 40 ft of rock in hilly country. Operating procedure included removing the lower seam back to the outcrop of the top seam, using the shovel to make a working bench for the dragline which completes the cut. Next the shovel removed part of the cover and made a bench on the upper seam for the dragline, which stripped to a 40-ft bank. After this coal was removed, augering was done to complete mining in the upper seam. The next step was to recover the lower seam, leaving a 90-ft highwall. Augering to a depth of 175 ft in the lower seam was the final stage in mining at this property.

An eight-step system for contour stripping and augering makes it possible for a West Virginia operator to remove 95 ft of overburden while recovering 13 ft of coal from two seams. A vertical overburden drill, 8-yd dragline and two highwall augers are key machines in producing 200,000 tons per year (*Coal Age*, March, 1958, p 90).

Effective bank preparation and skillful use of stripping equipment provide the foundation for mining 2-millions tons per year at a Kentucky operation. Bank preparation features include: (1) a company-built, high-capacity horizontal auger; (2) mechanical tamping of horizontal holes; (3) buffer shooting of vertical holes; and (4) self-propelled units with multiple air drills for sinking holes in a thin layer of limestone between two seams. Stripping units include an 18-yd dragline and a 33-yd shovel. A special shovel loads coal from the lower seam into trucks traveling on the upper seam (*Coal Age*, October, 1960, p 76).

THE WHEEL EXCAVATOR—The wheel excavator has been developed for use in the United States to cut the cost of moving material in 50- to 85-ft highwalls. The three objectives in using the machine are: (1) to handle overburden up to 85 ft thick, and place the spoil far enough away to avoid slides; (2) to cut the cost per cubic yard below that possible with conventional machines of equal size and capacity; (3) to leave any overburden not moved by the machine so low in height that capacity of the accompanying shovel or dragline will be increased.

WHEEL EXPERIENCE—Operating experience with the latest American wheel excavator at an Illinois mine demonstrates that they can dig 3,500 cu yd of overburden per hour and deposit it over 420 ft from the digging point. While operating 80% of the time, the wheel moves 2,000,000 cu yd per month. It can dig from 9 to 100 ft above the coal and spoil at a maximum height of 119¼ ft (*Coal Age*, August, 1959, p 82).

A significant saving in drilling and blasting cost is possible with the wheel excavator where it can be used. For example, one Illinois operator was able to shorten blastholes by 30 to 40% while eliminating the problems of hole squeezing and casing through sand. At the same time bit cost was reduced considerably.

At another wheel operation, a wheel strips and spoils 10,000 cu yd per shift, moving 25-30 ft and leaving 30-35 ft for a 33-yd shovel (*Coal Age*, July, 1956, p 60). Cuts taken by both machines are 45 ft wide, but the wheel-excavator cut is offset from 10 to 15 ft from the shovel cut to provide a bench that prevents spillage of the softer top material into the uncovered coal where the shovel would be required to re-handle it.

The narrow bench left by the wheel provides another advantage since the shovel can work to a nearly vertical face on the lower bench, instead of having to shape a sloping highwall to prevent sloughing of the softer top material.

Further improvements in wheel design to increase versatility and usefulness are possibilities for the future. For instance, serious consideration is being given to making changes that would enable the wheel to work on a bench much like a dragline when operating in tandem with a shovel. To make it possible for the wheel to be brought up out of the pit to the bench, one design change being considered is independent rotation of the digging boom so that the discharge boom could remain in a fixed position to transport material to the spoil area.

With the wheel operating from the bench it might also be necessary to lengthen the discharge boom to compensate for the greater distance the wheel would be working from the spoil area. Another possible refinement in wheel design would be to provide independent rotation for the discharge boom for even greater flexibility of operation.

HAULING SPOIL—Whenever possible, thick cover should be removed by casting. However, there are limiting factors, such as, spoil area available and range of the stripping unit. If the coal seam lies flat, is of average thickness and brings only an average sales price, it usually is not profitable to haul spoil. But if the coal is steeply pitching or is extra thick and the sales price is high enough, spoil haulage is feasible as a means of increasing the stripping range. Spoil haulage is most common in the anthracite area and is being carried on to a lesser degree in the bituminous.

Rugged, high-powered, end-dump trucks lead in spoil haulage, with tractor-scrapers and rock wagons moving a respectable portion of the material.

PIT CLEANING—Since the goal in stripping is to keep the stripping unit working at full capacity, pit cleanup should be left for auxiliary machines. Rubber- or tractor-mounted bulldozers are widely used for this work, along with the motor grader. The money invested in an auxiliary cleanup machine and its operator is justified by the increase in output of the stripping unit and a corresponding boost in available coal.

Although it pays to have an auxiliary machine clean the top of the coal, the stripping unit should take time to trim loose material on the highwall rather than leave it for the coal-loading shovel. Furthermore, it may be impossible for the coal shovel to reach the loose material and because of the hazard some of the coal will have to be bypassed until the next cut is uncovered. This procedure will result in a ragged pit and possible loss of coal.

Operating Stripping Machines

THE KEY to efficient performance of stripping units is keeping machine productivity as high as possible. The time spent in loading, swinging, dumping and returning for a new load must be kept to a minimum. A fully loaded dipper should be the goal in each cycle. To help analyze machine performance, some companies rely on recorders that indicate work time, angle of swing and the number of swings per shift.

A well-prepared bank makes possible fast loading and the finer the material the faster it can be loaded. But there is an economic limit to the amount of money that can be spent for explosives to break the rock. The type of overburden and the type of stripping unit are important in deciding how much explosive can be used.

IMPROVING DRAG LINE EFFICIENCY—Proper working of the digging face offers the best opportunity for achieving maximum production from a dragline with a minimum of power consumption and wear and tear on the machine. Slicing material off in layers will give more output than working in trenches. However, a "key" or trench cut along the highwall line frequently will ease the rest of the work. The dragline bucket should be loaded as quickly and hoisted as nearly vertically as possible to keep power consumption at a minimum. Poor operation, such as digging on a slope near the machine and lifting the loaded bucket approximately 45 deg with the vertical may consume up to 42% more power.

Quick loading and immediate hoisting will move the most yardage. By keeping the digger area under the boom, dividends will be reaped in greater output. The bucket should be filled while traveling two or three bucket lengths and then hoisted immediately. Every effort should be made to get a full bucket in the short travel but if it is not completely filled, it is best to lift and swing the load. By hoisting the bucket as soon as it is loaded, dirt pileup in front of the machine will be avoided and the danger of drag rope wear will be eliminated.

Sidepulling with the boom over-heats and wears swing clutches, puts unnecessary wear on the flanges of the boom-point sheave and may result in a twisted boom. This should be avoided to keep maintenance down.

ENGINEERING ANALYSIS—Industrial engineering techniques are being applied more and more to help mine management increase operating efficiency. And this practice is becoming more widespread in strip mining. A time study method designed for stripping shovels can be very simple, but the benefits can be large.

To get the most from a shovel time study, conditions under which the unit works must be studied carefully. Shovel performance can be affected directly or indirectly by width of coal pit or strip pit, width of haulage berm, water in the pit, haulage units and depth of overburden.

The type of overburden and how easily it can be dug is especially important. A series of time studies and a careful analysis of the results will show when the most economical point of overburden preparation has been reached.

RECORDER STUDIES—Time studies for shovels can be divided into two types. The simplest is a daily record of how many swings the machine makes and the length, in degrees of arc, of each swing. This information is obtained automatically by mounting a recording device, sometimes called a swing recorder, on the shovel. This device has a spring clock which pulls a roll of graph paper past a moving recording needle. The recording needle is synchronized with the movement of the machine's swing gears and records each swing on the roll of graph paper.

This type of study indicates when no useful work is being done—a straight line appears on the recorder roll. To provide management with information on these delays, shovel operators should be given daily delay forms on which to check off the cause. If these forms are designed properly, all the operator need do is place an X in the proper place to pinpoint the cause of the delay.

From the recorder sheet and the operator's delay sheet, engineers can make a complete report of how much time was spent digging, how much time was lost in delays and the number of swings.

BUCKET MAINTENANCE — Proper handling on the job, coupled with good maintenance procedures, will keep bucket maintenance to a minimum. Among the bad operating practices to avoid are striking the bucket against a solid object to loosen sticking material; dropping the bucket, especially with the teeth down; slapping the bucket against the boom while hoisting; and pulling the drag-bail socket into the fairlead.

Bucket teeth take a beating and must be kept sharp for good digging. Spare sets of teeth should be kept on hand for frequent changing so that worn units can be built up with hard-surfacing materials. Under no conditions should teeth be permitted to become badly worn.

Small cracks develop in the bucket from time to time as a result of accidental abuse. These weak spots should be repaired as quickly as possible to prevent big repair bills later. Many companies find it profitable to buy a minimum of two buckets for each dragline so that bucket maintenance can be done on the regular work shift without reducing dragline output. When repairs are needed the bucket is changed on the off-shift, or with a minimum of delay if the dragline works around the clock. Two buckets kept in good condition and used alternately will last longer than buckets bought one at a time and used continually until worn out.

SHOVEL OPERATION—As with dragline loading, the bank should be removed in slices in shovel work. The thickness of the slice should be such that the dipper will be filled as it reaches the top of the bank. It is usually good practice to dig the top half of a high bank first. This method keeps sloughing into the pit to a minimum and avoids lowering of the dipper to the bottom each cycle. Consequently, cycle time is speeded up and output is increased.

Load indicators are also gaining in favor to show the operator when the dipper is fully loaded and ready to be hoisted (*Coal Age*, October, 1953, p 80). The operator can be trained to hoist and swing as soon as a full load is indicated on a meter in his cab rather than relying on personal judgment. An indirect benefit from load indicators is less overloading and therefore fewer breakdowns.

Short moves should be made to maintain an efficient digging position. Digging beyond the boom point should be kept to a minimum. When working with too much reach, too much time is lost crowding and retracting. Sweeping the dipper back and forth to level off spoil causes side strains and wear on the boom, dipper stick and dipper.

Augering

Since the highwall auger was introduced to the industry, it has grown to the point where it is producing more than 8 million tons a year. When teamed with stripping equipment, such coal-recovery drills have permitted stripping to be done to higher banks. The combined cost of auger coal and strip coal from the higher bank can be made to equal or better the cost when stripping alone is done under thinner cover.

Coal produced by augering usually is dry, clean and has a good proportion of lump sizes. However the proportion of lump usually decreases as the augering depth increases. Where the seam has a layer of

high-ash coal on top of it, selective mining can be practiced and clean coal produced without preparation.

Augers are available in diameters ranging from 16 to 84 in, and are capable of producing as much as 25½ tons of coal per minute. To increase flexibility in operation, augers are available with conveyors that permit coal to be discharged on either side of the unit.

A three- or four-man crew usually handles all the work involved in the augering and is supplemented by a group of truck drivers.

PREPARING FOR AUGERING—If augering is to be done as part of the stripping operation, make preparation as stripping progresses. Care should be taken in blasting so that the highwall will be left in the best possible condition. A highwall slide can endanger the lives of men or result in serious damage to the auger as well as cause a loss in production.

A clean well-drained pit of suitable width for auger operation should be left as stripping progresses. It is much more economical to anticipate the use of the auger and make the necessary preparations as part of stripping than to do it later. It also is desirable to auger as soon as possible after stripping is completed and while the highwall is in the best condition. If there is coal remaining beyond the augering limit, solid blocks of coal should be left at regular intervals to permit access for future deep mining. The size of block to be left depends upon the thickness and type of cover, the thickness and the strength of the coal, and the mining laws.

AUGERING METHODS—Augering usually is done by drilling single holes to the desired depth with a unit that takes nearly the full seam height.

The depth to which augering is carried out depends to a great extent on the coal thickness, whether the seams roll or are flat, and whether they are strong enough to stand after penetration and not foul the auger. Distance between holes also depends on the strength of the coal and the overlying rock.

AUGERING EQUIPMENT—Equipment requirements for augering depend upon the application. For example, if the auger works in conjunction with stripping a bulldozer and trucks will be the only additional equipment that will be needed. Service and maintenance trucks used for the stripping equipment can take care of the auger. If augering is done independently of stripping, either in abandoned strip pits or in areas where no stripping was done a small shovel and service facilities probably will be needed. The shovel will be needed to provide a working bench along the outcrop or help the bulldozer clean old pits.

AUGERING RESULTS—At one West Virginia operation where a 48-in auger recovers 40 tons per shift, three men perform all the work connected with augering. One man operates a bulldozer to move the auger to new drilling sites and to clean the pit in the augering area. The other two men operate the auger and add or remove auger sections.

A crew of four men produces 140 to 150 tons of coal per shift with a 30-in self-moving auger that bores holes 125 ft deep in an Alabama pit. Three men remain in the pit and the fourth drives loaded trucks to the preparation plant. One truck serves as a surge bin while the driver makes a round trip to the plant with the other.

A self-moving 47-in unit works in a mountaintop pit only 26 ft wide. Self positioning with three hydraulic positioning jacks make it possible for the unit to be moved fast and easily to a new hole site.

Three augers, two full time and one spare, are used at this property to recover coal that could not be stripped because of the hazard of spoil rolling or sliding downhill and damaging vital mine installations (*Coal Age*, September, 1956, p 72).

In Ohio, a 30-in self-moving auger produces 400 to 500 tpd in three-shift operation. Working in areas previously deep mined, the unit has produced up to 275 tons in a single shift (*Coal Age*, July, 1957, p 60).

Production of 150 tpd with six men, including truck drivers, is achieved with a 24-in auger. The company uses trucks for overnight storage to get full-shift operation. Four trucks are used regularly by the two drivers. While they shuttle back and forth between the pit and cleaning plant, the elevator operator spots empty trucks. When a truck is filled it is driven from under the elevator and parked headed toward the preparation plant. When a driver returns with an empty truck there is a loaded one waiting for him (*Coal Age*, December, 1956, p 54).

New entries in the auger group are the twin-head and triple-head machines capable of boring two and three holes at the same time and the 7-ft unit that produces up to 25½ tons per minute. The multiple-head units break out the small pillar between the holes and thereby increase recovery. Capacity is boosted and, as a result, thinner seams that previously could not be mined profitably now many be recovered.

Coal Loading

BREAKING COAL—Where the coal is of average thickness and hardness explosives used in breaking the overburden usually will loosen the coal sufficiently so it can be loaded easily without being blasted. But sometimes it is too hard to be broken this way or the nature of the overburden may prevent it.

At other operations, it is necessary to drill and shoot the coal in a separate operation. Self-propelled combination machines made up of drills, compressors and brooms are frequently used for this work. Either one or two drill arms are mounted on these units to put down holes in a minimum of time. The power broom is used to sweep the top of the coal before holes are drilled and is disengaged from the power unit during the drilling cycle. Sometimes a handpulled wagon with a gasoline-powered drill is satisfactory.

RIPPING COAL—Breaking coal with a tractor mounted ripper is proving an effective and economical aid in keeping cost to a minimum. This technique is made possible by the recent development of large hydraulically controlled rippers mounted on the rear of tractors having engines with more than 300 hp.

With tractor weights approaching 70,000 lb, only the tractive effort of the prime mover and the size of the tooth limit the depth of penetration. Ability of the modern tractor to develop up to 54,000 lb of pull at the drawbar makes riping possible in seams up to 6 ft thick. In an Illinois mine, a tractor-mounted ripper with an 8-ft tooth breaks a 4½-ft seam of coal at a saving of $42,000 per year over conventional methods. (*Coal Age*, February, 1958, p 148).

Riping a 3-to 6-ft layer of shale on top of the coal and then the coal results in greater coal recovery and a reduction in the quantity of fines and large lumps going to the preparation plant at a western Kentucky operation. Only 45 min is required to rip enough coal for an entire shift of loading. The decrease in fines going to the preparation plant lightens the load on the wet tables and crusher, making it possible for the plant to handle more coal (*Coal Age*, January, 959, p 82).

COAL CLEANING—Preliminary cleaning before loading, where desirable, can be done by tractor-scrapers, bulldozers, graders, rubber-mounted scoop loaders or power sweepers. If there are any clay veins in the coal or the top of the coal is very irregular, it may be necessary to remove part of the dirt by hand. Hand cleaning, however, is expensive and should be avoided where possible.

LOADING METHODS—First consideration in choosing a coal-loading machine is to match its capacity to the ability of the stripping unit to uncover coal. Sometimes it is desirable to have excess coal-loading capacity so that any time lost by transportation or tipple delays may be partially regained by faster loading. By loading trucks rapidly with an oversize shovel haulage can be restored to normal in a minimum of time.

SPECIAL SHOVELS—If the coal seam is thin, consider the horizontal-thrust shovel or the skimmer unit, either of which moves the dipper parallel to the bottom where loading. These units have the advantage of scooping up a wide channel of coal without disturbing the bottom.

A horizontal-thrust coal loader with faster loading action in thin coal helped break a production bottleneck at an Alabama property. It has a 7-ft independent loading action which enables it to go through numerous loading cycles while standing in one place (*Coal Age*, May, 1961, p 106).

SPECIAL DIPPERS—If the coal seam is split into two or more parts by several feet of rock, the specially designed dipper on a conventional shovel may work out better. The top layer of coal can be scooped off and then the same shovel can be used to remove the rock covering the lower portion of the seam. If the coal loader cannot be spared for the rock job, the regular stripping unit can be used on the off shift to remove the thin layer of rock.

When the coal is more than 2 or 3 ft thick, but is extremely hard, a divided dipper can be used effectively to limit the size of lump that is delivered to the truck and therefore to the preparation plant.

To minimize spillage when loading the top seam into trucks on the lower seam, a special

SPECIAL shovel with horizontal-thrust action simplifies loading of thin seam.

variable-rake-angled dipper was developed. The dipper is set for the proper rake angle for digging, then when raised for dumping the angle is readjusted through a control in the operator's cab to the proper angle for low dumping. Afterwards the rake angle is reset for digging.

STOCKPILING—Where two-shift operation of the preparation plant is not desirable and the coal is thin, top efficiency from the loading and hauling units can be achieved by heaping the coal to one side of the pit on the off shift so that loading-time will be as low as possible on the regular shift. The loading shovel thus can fill a truck faster and coal will be carried to the tipple faster.

INCREASING COAL RECOVERY—The importance of recovering all the coal that is uncovered cannot be over-emphasized, particularly where the seam is thin. If by careless operation of the coal-loading shovel 3 in of coal is left on the bottom over an area of one acre, the loss will be about 450 tons. If 10 acres of coal are stripped in a month, the resulting total loss will be 4,500 tons. At a sales price of $4 per ton, this amounts to $18,000 per month.

If working completely to the bottom results in much overshooting or in too much loss of time, and there is considerable coal involved, a bulldozer may be assigned to accompany the loading shovel. It can rip up the bottom coal and keep it pushed up to the loader with a minimum of digging into the bottom and at a cost still representing a considerable saving over leaving the coal or delaying the loading.

If a washing plant with sufficient capacity is available some bottom material can be tolerated with either shovel or bulldozer cleanup. If a washer is not available, more care is required, but it still is possible under many conditions to increase recovery without undue contamination.

Another place where good loading procedure pays off is along the outer edge of the coal where it is in contact with the spoil. If a 6-in strip of coal is left along 1 mi of a seam of coal 60 in thick, the loss will be about 528 tons of coal. At $4 per ton, this will be $2,112.

To provide a solid vertical edge and prevent losses such as this, one company developed a marking machine that shears through the coal, marking the loading limit for the shovel and leaving a smooth vertical wall on the bench. Estimated savings were about 200 to 400 tons per acre.

Transportation

SELECTING TRUCKS — Choosing the largest available unit does not always result in a lower haulage cost per ton because final truck selection is based on many factors including production, pit width, types of roads, grades, distances and size of loading shovels. Wherever possible, the size of the haulage unit should be matched to the capacity of the loading shovel. For example, a 5- to 7-yd shovel works well with a 40-ton truck and a 3- to 4-yd shovel teams well with a 25-ton hauler. A good rule of thumb is to use trucks with four to five times the dipper capacity of the shovel.

Overall height of the truck should be such that it makes a good target for the loading shovel. Length should be minimum and width a maximum so that the shovel loading cycle can be kept to a minimum. Ability of a truck to turn around in cramped quarters in as short a time as possible and get under the shovel without delay should be considered to avoid traffic congestion.

Coal-hauler size runs up to 50 tons in anthracite, and up to 80 tons with tractor-trailer units in bituminous. Power is supplied by engines up to 450 hp. In recent years trailer weight has decreased, and payload and speed have increased by 25 to 30%.

TRUCK DESIGN—New ideas constantly are being introduced in truck design to increase payload or improve performance. For example, tractor-trailers now in service at an Illinois mine feature a tractor that has no front axle. Instead wheels are mounted individually on a spindle which in turn is fastened to a hydraulic shock absorber. The suspension units act as giant kingpins and support the front wheels while making it possible for them to be steered. Two of the units replace the front axle, two spring the drive axle and two support the trailer axle.

With few minor changes, one is also used to connect the trailer to the tractor. One advantage of this type of connection is that the loaded trailer is carried on a cushion of air; hence, shocks are absorbed by the connecting member rather than transmitted directly to the tractor. Another advantage is that the connection is located 30 in ahead of the centerline of drive axle and thus gives capacity loading of the front axle.

A special airplane-type propeller cooling fan is used on the engine, saving 66⅔% in the power required for cooling. Controlled thermostatically, the fan runs only when engine temperature is above 190F.

The use of alloy steel for fabricating trailers capable of carrying 80 tons of coal results in more payload per trip. Other improvements in design make it possible for the unit to carry 4.4 cu yd per foot of trailer compared to 2¾ cu yd in a conventional trailer.

TORQUE CONVERTERS—Torque converters make for smooth truck operation, less lugging and lower maintenance. They also have made it possible for loading trucks to climb steep grades, thus shortening haulage routes. In some cases, a 48-ton truck with torque converter can haul coal at up to 30% less per ton-mile than a 37 ton truck with a standard transmission on the same route.

AIR STARTERS—Air starters have been used effectively on large coal haulers to eliminate all batteries except the 6-V units for headlights. Starters are operated by compressed air supplied at 100 psi from a storage tank on the tractor. Trucks can stand idle for 4 or 5 days and there still is enough air in the tanks to start the engines.

HYDRAULIC RETARDERS—Hydraulic retarders are available for controlling the speed of trucks on long steep downgrades. The unit also acts as a governor. Mounted on the drive shaft of the truck, the device is designed so that when the shaft speed increases, the retarder resistance automatically increases at a much faster rate. Therefore any tendency of the truck to run away is curbed by the retarder which piles up resistance very rapidly when the truck's speed tends to increase. A control valve near the driver regulates the degree of braking available by controlling the oil passing into the retarding device. Aside from slowing the truck, the device is said to save tires, fuel, time and brake lining.

ENGINE HEATERS—Cold-weather starting of truck engines is simplified at an Ohio mine by electric engine heaters. Each engine has its own electric heater which has an aluminum jacket enclosing a 2,500-W heating element. It is permanently installed in the engine's cooling system.

At the end of the shift each driver parks his 51-ton coal hauler beside the shop and connects the heater to one of the all-weather outlets mounted on the outside of the shop wall. The heater keeps the engine water temperature at about 120 F. As a result, little or no difficulty is experienced in starting the engines in sub-zero weather.

TRUCK-RAIL HAULING — Where the haul is over 3 or 4 mi, the topography is favorable and sufficient coal reserves are

available, the use of a field station and rail haulage to the preparation plant is worthy of consideration, particularly since the advent of the small diesel locomotive. With this type of setup one man can load a trip of cars, haul it to the preparation plant, dump it and return to the field station in a minimum of time. A minimum of trucks are needed to shuttle back and forth between the pit and the field station. Consequently, truck maintenance costs also are lower and fewer men are needed for operating and servicing trucks. A further advantage is that road maintenance will be lower.

OVERLAND BELT—An added starter in the transportation field is the overland belt system that carries coal from portable bins near the pit to the cleaning plant (*Coal Age*, August, 1954, p 64). Where the land is gently rolling and stripping can be carried out in a wide area, the overland belt offers the following advantages:

1. Eliminates the cost of building and maintaining long, high-speed haulage roads.
2. Permits movement of larger tonnages with fewer or smaller trucks.
3. Permits recovery of belt after the property is worked out. Roads cannot be recovered.
4. Reduces the manpower required for maintenance of trucks.
5. Requires a smaller supply inventory and less garage space.

Road Building

Main roads should be built with wide beds and have good alignment to permit trucks to run at top speed. All curves beyond the gentlest should be super-elevated.

Roads should be planned well in advance and when fills are needed to get the proper grade, they should be built up well ahead of the time they are needed. Fills should be compacted as they are made and topped off with one or more feet of rock that will serve as a road base. After this material is compacted, a top layer of crushed rock should be added and compacted. This top layer usually is applied in several layers and compacted between each. Material used for the top layer includes Nos. 3, 4 and 6 crushed limestone, 2-in slag or red dog.

SURFACE MAINTENANCE — One or more road graders, depending on the length of road to be maintained, are used at most operations to keep the running surface smooth. Roads should be sprinkled regularly during the dry, dusty season not only to maintain good visibility but also to keep dust out of truck engines and moving parts, thus helping to reduce maintenance.

EFFECT OF GRADES—Grades should be avoided as much as possible to keep power requirements down. For example, it takes twice as much force to move a 20-ton load up a 5% grade as on the level. Where grades must be negotiated, stepped-type roads can be used to advantage. This type of road involves alternate stretches of level road and short comparatively steep rises. Therefore less clutching is required in trucks equipped with standard transmissions and there is less lugging on the up grade and over-speeding on the down grade. Constant shifting and lugging results in reduced life for engine, transmission and clutch.

Entrances to the pit should be one way if possible. Turning and backing large haulage units takes time and thus reduces haulage efficiency. Proper design of turn-ins can eliminate this problem.

Power

IN LAYING OUT a distribution system, three primary factors are involved. First, the system must be able to supply the equipment without objectionable voltage regulation from an operating standpoint and at the same time stay within reasonable economic limits. Second, the system must provide adequate protection for personnel and equipment. Third, the units in the system must be adaptable to relocation to keep up with the change in the load requirements.

Public utility companies supplying the energy for operating strip mine equipment are faced with the problem of greatly increased demands on their systems. Many times they have been able to handle this increased capacity by switching to higher voltage transmission lines. Mining companies using large quantities of energy can get a more favorable contract if they receive power at the higher voltage. To do this the customer must purchase a transformer substation capable of reducing the voltage to that required for the portable equipment.

TRANSFORMATION—Voltage may be reduced in either a one- or two-step transformation. With one-step transformation, primary mine distribution usually is 2,300 or 4,160, with 6,600 and 7,300 V coming into the picture as a result of heavier demands imposed not only by the increase in machine use but by higher horsepower per machine. In two-step transformation, the "super-primary" voltage usually is 13,000. Permanent transformer stations may employ either single- or three-phase transformers, with a trend toward the latter. A number of strip operations also employ semi-portable stations completely or to supplement permanent stations. Commonly called unit substations, they are based on three-phase transformers. Typical ratings are 1,500, 2,000 and 2,500 kva, with the top usually 5,000. Normally these stations include lightning arresters, circuit breakers, ground-protective equipment and other central and protective facilities.

PRIMARY DISTRIBUTION — Primary distribution systems generally fall into three general classes:

1. Pole-mounted high lines.
2. Cable systems.
3. A combination of pole line and cable line.

Pole-line practice is largely standardized, with a main line a maximum of 1 mi in advance of the pit and parallel to it. From this main line, pole-line laterals at intervals of 1,200 to 1,500 ft are run to the pit, terminating in switchhouses which supply auxiliary transformers for low-voltage equipment, and also supply the cables on the larger high-voltage equipment. As the pit moves across country, the laterals are shortened at intervals until the pit approaches the main line, which then is moved to restart the cycle. Cables on the equipment usually are 1,000 ft long. Thus, with a lateral spacing of 1,200 to 1,500 ft, equipment can operate freely between laterals with enough cable to spare to permit terminating laterals some distance back when shortening is necessary.

SUBSTATIONS IN PARALLEL — The latest development in strip mine power systems is operation of substations in parallel (*Coal Age*, October, 1956, p 60). At the present time two skid-mounted 1,500/1,725-kva substations are in operation with plans for adding a third unit. The pit power distribution system is entirely by portable cables and multi-conductor plugs and sockets.

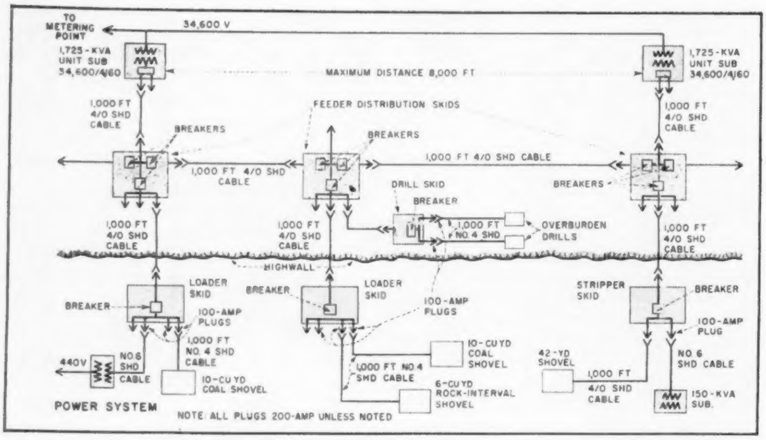
Special mine power cables are used between breaker skids. The cable is similar to the Type SHD portable shovel cable in that it has a copper basket weave over individual conductors. It differs in that it has smaller ground conductors and a thinner outer jacket. This type of cable was bought at a saving of approximately 46%. It is used exclusively on the highwall and seldom, if ever, will it be necessary to move it while it is energized.

The theoretical ideal conditions for paralleling three-phase transformers are:

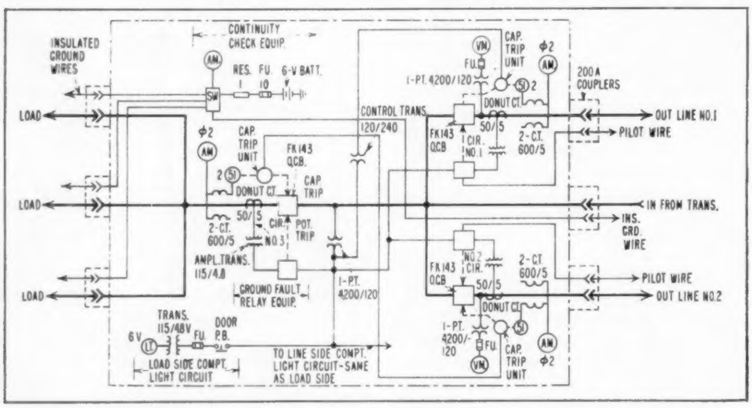
1. Same phase rotation
2. Same phase-angle shift
3. Same polarity
4. Identical turn ratios and voltage ratings
5. Equal per cent impedances
6. Equal ratios of resistance to reactance.

Since the substation units at this mine are identical, the last five items above are automatically taken care of. To parallel two or more substations phase rotation must be the same. Phase rotation refers to the order in which the terminal voltages reach their maximum values. In paralleling, those terminals whose voltage maximum occur simultaneously are in phase and are connected together by the circuit breaker. Each substation unit is equipped with necessary equipment that will not permit the breaker to be closed, paralleling two substations unless the voltages on both sides of the breaker are the same phase. Added safety features are incorporated within the substation design to indicate to the operator of the substation the unit voltage level and load at all times on both sides of the breaker.

GROUND-CABLE SYSTEMS — A fair number of strip mines use the "ground-cable" system instead of pole lines, or a combination of ground cables and pole lines. Otherwise, the basic plan is the same. A complete system consists of the main cable and the laterals, the cable being fabricated in sections of 1,000 to 1,500 ft as a rule with connectors for termination in switch-houses or for joining the main-cable lengths by junction boxes. Several types of cable may be employed but the most common is Type SHD. Construction includes copper shielding braid over each insulated conductor to equalize surface stresses and eliminate static discharge—the cause of corona cutting. The shielding must be at ground potential at all times, and therefore must be properly grounded, which also eliminates the hazard of shock in handling the cable. Grouding conductors are placed in interstices. It is the safest and most widely used for high-voltage (up to 15,000) portable power applications.



HOW power is distributed in loop system that has two easily moved skid-mounted substations plus portable auxiliary units.



ONE-LINE DIAGRAM of triple-breaker skid shows how ground-fault and continuity-check circuits are built in.

Within limits, distance of transmission of 4,160 volts becomes critical, as a rule, only with the heavy loads encountered in the use of large shovels and draglines rated from 20 to 25 cu yd and up where connected horsepower per unit runs from approximately 2,000 to 5,000. Under such circumstances, the transmission distance for 4,160 volts normally should not exceed 5,000 to 6,000 ft. Above that, at high-voltage—33,000 for example—a pole line is cheaper to construct and also improves regulation and reduces power loss.

With the success of the 60-yd unit and advent of the 70-cu yd shovels, operating voltage moved up to a new high of 7,200 volts. Power is fed directly to the shovel cables from 5,000-kva transformers after passing through automatic circuit breakers.

The 6,900-V cable to the 60-yd shovel has one of the three ground wires insulated and a 110-V potential is maintained between the uninsulated ground wire and the insulated wires. On the shovel there is an annunciator circuit connecting the insulated wire and the equipment frame.

CHOOSING PROTECTION — Primary items involved in the selection of a protective grounding system include:

1. The maximum value of machine frame to ground voltage during a ground fault.
2. The magnitude of fault impedance that can be relayed.
3. Provisions for checking continuity of the ground-wire circuit.
4. Establishing a protective ground separate from the substation ground.
5. Proper choice and rating of components to maintain low frame-ground voltage in event of failure to trip on a ground fault.
6. Immediate isolation of a faulted feeder from the remainder of the system.

FRAME GROUNDING — The frame-to-ground voltage that is developed under fault conditions is approximately the ground current times the impedance of the ground wire. This is the potential to which a man standing on the ground and touching the machine would be subject to when a ground fault occurs.

In a system having a resistor limiting ground fault current of 25 amp where the ground-wire impedance in the cable is 2 ohms, the machine frame-to-ground voltage would be 50. In a system having a 50-amp ground current limit and a 2-ohm impedance in the ground wire, the voltage will be 100.

If more than one substation is used and each has its own ground-current limiting resistor to keep each ground current at 25 amp paralleling them will permit a total of 50 amp to flow in the ground wire in event of a ground fault. The potential drop in the ground wire then would be 100 V. If more than two similar substations, each with its own ground-current limiting resistor are used the total ground current that would flow in the cable ground would be the sum of all substations.

The grounding resistor will establish the maximum ground current that can flow under solid fault conditions. The tripping current that would isolate a faulted feeder should be considerably less. The ratio of limit value to ground relay pick-up value determines the fault resistance that can exist and still obtain tripping. The higher this ratio the greater the fault resistance can be for relay pickup. It is improbable that a high-resistance will clear, therefore its immediate isolation is advantageous. The ability to relay a high-resistance fault is important in safety grounding systems.

For example, one recommended plan uses a 25-amp ground-current limiting resistor and a ground-detecting transformer and relay combination set to trip at 5 amp ground fault. On a 4,160-V system this resistor value from ground to each phase would be 96 ohms. In a 4,160-V system the line to neutral voltage is 2,400. Thus a total resistance—grounding resistor plus ground wire plus 2,400 divided by 5, or 48 ohms can still obtain 5 amp in the ground circuit. Subtracting the 96 ohms of the resistor from the 480 ohms would permit 384 ohms in the fault. Thus fault resistance between 380 ohms and 0 ohms could be relayed.

Successful functioning of the safety grounding circuit depends on the ground conductors from the machine frame back to the substation being intact. If the ground is broken or an open terminal connection develops, the protection is impaired.

CONTINUITY CHECKS—There are various ways of checking ground-wire continuity. Sometimes a check is made at the start of the shift by imposing an artificial ground fault on the unit and noting tripping of the feeder breaker. The latest method is to provide continuous monitoring of the ground-wire circuit. Sometimes an alarm sounds in the equipment and warns the operator that the ground circuit is not intact. Other methods actually trip the supply breaker. In each of the continuous systems either a pilot wire is required in the cable or one of the grounding wires must be insulated from the other ground wires.

SUBSTATION GROUNDING—To minimize the rise in potential of the protective ground and the frames of mobile machines to which it is connected during the lightning arrestor discharge, or in case of flashover of any of the substation equipment, the substation protective ground resistor should be connected to a separate ground. This ground should have as low a resistance as possible—under 5 ohms—and should be located some distance from the main substation ground.

POWER FACTOR—To prevent power penalties resulting from power factor below that specified in the power contract, synchronous motors, 0.8 leading, are installed on the m-g sets on large excavating units.

PORTABLE MAGNET helps reduce tire damage by picking up nails, bolts, ends of welding rods or pieces of wire rope.

HAND WINCH on float-mounted pump simplifies handling of suction line.

Without correction, power factor would usually average between 68 to 85%, but with the proper correction will be up to 90 to 95%, which will be above the penalty area.

CABLE TESTING AND FAULT-FINDING—Insulation failures and shorts in high-voltage distribution or service cables in strip pit can cause major delays unless special facilities are provided for locating them. Without such special equipment, about the only method is to apply high voltage and current and blow the cable up at the point of fault.

Equipment for testing and fault location may be made or purchased. A testing outfit that may be made up from purchased components employs, among other items, a half-wave rectifier tube and filament and plate transformers to produce DC at up to 30,000 V and 40 miliamp, or sufficient to test up to 7,500 V. In operation (*Coal Age*, May, 1953, p 108) voltage is applied slowly to one conductor, with other conductors, shield or shields and ground wire or wires grounded. When the cable is fully charged, the current flow is the true leakage current, registered on a milliammeter. The voltage is held for a period and leakage current is determined at intervals to develop a polarization curve. The shape of the curve indicates the electrical condition of the cable and exposes potential insulation weaknesses.

For locating faults, the test equipment is modified by the addition of a spark gap and condenser. Location is achieved by picking up the discharges sent forth by the condenser and spark gap, which are audible at the trouble spot if there is water soaking or there is not a dead short. Where this is the situation, the observer has only to walk the cable. If the fault resistance is very low, dead ground or under water, a pickup coil and earphones are employed and the fault point is marked by a change in the signal. Commercially developed units may be purchased to achieve the same results.

Drainage

PREVENTING INFLOW — To keep drainage costs to a minimum, water should be kept from entering the pit and off the haulage roads. Several ways of doing this include: (1) diverting streams to new channels to prevent seepage into the work area; (2) ditching above the highwall to divert surface runoff away from the pit; and (3) building flumes to span the pit.

GRAVITY DRAINAGE — When water does enter the pit, as a result of rainfall or seepage, gravity should be used as much as possible to remove it. By exercising care in spoiling, leaving windows in the spoil areas or putting in crib culverts or drain pipes at intervals, water can be handled economically. If grades favor it, one end of the pit may be kept open to release all the water. In some cases it will pay to blast a ditch in the pit floor so water can flow by gravity to a drainway through the spoil area.

PUMPING — Portable pumps, either mounted on skids or wheels, are the leaders where pumping is required. These are used in a variety of sizes and capacities, depending on the job to be done and are powered either by electric or diesel motors. Many of the units are controlled by float switches that stop or start them automatically.

Air-cooled diesel engines are contributing to lower pumping costs at mines where electricity is not available. One company reports a saving of $6.50 per day in fuel alone in the operation of a 4-in pump formerly driven by a gasoline engine. Another company says that an air-cooled diesel has seen service for 2 yr and the only maintenance required has been regular changing of oil and fuel filters.

The hose is popular for temporary water lines but is frequently supplemented by a variety of new materials, including flexible plastic, special rubber and aluminum pipe. Resistance to corrosion, rot and abrasion have made plastic pipe more popular, while ease of handling makes aluminum desirable. Threadless couplings, in addition to the advantage of fast joining and installation of pipelines, also permit individual joints of pipe to be rotated 180 deg if a small leak occurs in the bottom as a result of abrasion. Thus pipe life can be greatly increased. Check valves should be included in all suction lines to eliminate the need for priming pumps. However, this may not be desirable in cold weather when there is danger of the lines freezing. If corrosion and abrasion are problems, impellers and pump interiors can be coated with rubber-base material to increase their life.

NEUTRALIZING WATER—To prevent acid water from entering the water sheds of surrounding streams, one company developed an automatic device that provides low-cost water neutralizing (*Coal Age*, February, 1957, p 101). Six sumps, each with its own pump, are strategically located on the property. Each pump has a separate automatic treating tank. Water is treated automatically with lime solution and delivered to settling areas before it is permitted to enter the water basins.

A steel mixing tank at each pump is partially filled with water and 400 lb of hydrated lime is added. As the lime enters the tank it is thoroughly mixed with the water by a power-driven agitator.

Lifting cups attached to one end of the agitator pick up the solution at one end of the tank and discharge it into an adjustable trough at the top of the tank. The trough leads to a 2-in hose that carries the lime solution to a point adjacent to the pump suction line. As the solution flows into the acid water it is pulled into the suction line of the pump. In the short journey to the pump and in the pump itself the solution is mixed thoroughly with water to neutralize the acid.

A tank of solution lasts each pump for 2½ to 4 hr, depending on the acidity of the water. The quantity of solution delivered to the sump is controlled by moving the adjustable trough.

An automatic lime-feeding device requiring no power other than the water itself provides low-cost water treatment in isolated areas at a Pennsylvania strip mine (*Coal Age*, March, 1958, p 148). Features of the unit include operation by as little as a 1½-ft fall of the water being treated; functioning on 5 gph or less; light enough to be carried to the site if necessary; automatic proportioning of lime according to volume of water being treated; adjustable lime feed to meet varying acidity; and 2 to 8 hr of operation without refilling.

Quality Coal Preparation

Since 1955

Percentage of coal mechanically cleaned shows further significant increase. At the same time, number of new raw-coal operations also increased.

Heavy-medium washers stage major gains; cyclone unit comes in as a fine-coal cleaner.

Fine-coal treatment marked by significant rise in flotation, in addition to cyclone use.

Water cleanup and reclamation circuits widely adopted.

Fluidized-bed units take over almost completely in drying.

Number of major 3- and 4-man plants increased significantly, with most new plants now designed on that basis.

Ahead to 1965

Further increase in coal mechanically cleaned, and at the same time also a rise in number of raw-coal plants.

Air cleaning possibly set for a significant comeback.

Computer programming of the operation of preparation plants expected to become the common practice.

Raw-Coal Storage

MINIMUM CAPACITY where storage is designed to provide a reserve against production interruptions, rather than merely as a convenience in dumping and transferring coal, normally is at least ½ hr of rated plant capacity. Anything less is not likely to be of benefit in reducing or eliminating the consequences of irregular plant feed or mine or plant breakdown.

Much-larger storage is an increasing trend, using either single bins, multiple bins or ground facilities. Bin capacities of up to 15,000 tons single are fairly common, as also are ground-storage installations up to 300,000 tons or more.

Underground Storage

Capacity of one hopper feeding a slope belt at a plant rated at 500 tph is 260 tons. The hopper is 16 ft wide and 66 ft long. Maximum depth is 18½ ft. Designed to receive coal from a belt system, this hopper is fitted with a shuttle-type distributing conveyor with hinged boom end. The boom section permits laying coal into the hopper with minimum degradation. The shuttle principle also makes possible maximum use of bin capacity.

The dumping characteristics of dropbottom cars also permit maximum use of bin capacity and thus can cut down size and depth; for example 96.7 tons in a bin 40x12 ft by 10 ft deep.

Surface Storage

Although some form of bin or hopper still is the most popular form of surface storage of raw coal there is as previously noted a trend toward open or ground storage.

OPTIONAL-FLOW STORAGE — Optional-flow setups are those where the coal usually goes to the plant but can be diverted into storage, either in bins or hoppers or on the ground. Three accompanying diagrams show (1) feedback to a slope belt from the plant bin, (2) dual steel silos following a truck-dump hopper, and (3) distribution to two ground pits after rough cleaning. Ground pits also may be located over slope belts, or flat storage areas may be served by conveyor-stackers with parallel conveyors, supplemented by dozers or front-end loaders, to return the coal. Truck handling is a common practice also.

IN-LINE STORAGE—In an increasing number of instances the storage facilities are inserted in the line of flow so that the coal must pass through them. In many instances this simplifies the installation and can save in capital and operating costs.

Hoppers are fairly common, with one open-top concrete installation at the head of a slope, equipped with 26 feeders, holding a total of 15,000 tons. Though storage is the main objective some blending is achieved.

Conveyor stocking and reclamation is the logical practice with in-line ground storage. An accompanying illustration shows a 12,000-ton facility at a new slope mine.

For a complete discussion of these and other forms of storage, prepared coal as well as raw, see the special *Coal Age* Operating Guide, "Mine Storage of Coal," December, 1959, p 105.

Raw-Coal Blending

BIN FACILITIES—Since the usual goal in blending raw coal is splitting it up into small increments and then recombining it, also in small increments, the normal blending plant consists of a multicompartment bin with a relatively large capacity—usually 1,000 to 2,000 tons or more up to 10,000. The more the compartments, within reasonable limits, the more the opportunity for splitting and recombining. Also, to facilitate putting small portions of coal into each compartment, the usual practice is to employ a belt with a traveling tripper, though other methods of distributing the coal may be employed. To complete the recombining —and blending—coal normally is withdrawn from all compartments at the same time. Variable-speed feeders are common for this purpose.

A less-common type of blending is getting the desired mixture of coal from, say, two different seams. This requires a bin or set of bins for each, which may be filled in any of the usual ways. Blending of two coals also may be accomplished by feeding as desired from side-by-side ground-storage piles to a plant feed conveyor.

PROPORTIONING—Where two or more coals may come via belts from different mines, belt speeds may be controlled automatically to insure that the desired blend is constantly maintained. (*Coal Age*, August, 1958, p 108). Other types of feeders may be similarly equipped if desired.

Primary Breaking

PRELIMINARY BREAKING and certain rough cleaning usually go hand in hand, although, for example, if coal is being transferred from a hopper to a crusher preceding a slope belt underground, no attempt is made as a rule to remove rock or impurities before the breaking process. On the surface, however, it is generally accepted that where substantial quantities of rock are encountered it is best to remove at least part of it before sending the product to the crusher. Consequently, particularly where all the coal is to be washed, it is common practice to employ a picking table or—as is increasingly the case—a scalping screen and picking table ahead of the crusher.

Preliminary breaking is almost entirely the province of the roll-type machine although some pick breakers are employed to get closer to the desired objective of reduction with a minimum production of fine sizes. An alternate also providing rough cleaning is the rotary screen-type breaker.

Roll diameter, tooth design, tooth positioning and speed are major factors in holding down fines, along with keeping teeth in good condition at all times. Double-roll crushers are considered to give a higher proportion of coarse material because abrasion against the plate is eliminated. Feeding practice also influences results in this direction. Consequently, usual practice is to scalp out fines and send only large material to the crusher.

STAGE CRUSHING—In anthracite, particularly, stage crushing has been the prac-

tice of many years because of the nature of the raw product and also the size list produced.

To avoid a multiplicity of units, crushers are offered with a second stage of reduction built into them.

Rough Cleaning

THE MAJOR rough-cleaning methods are as follows:

1. Picking table receiving all the mine run product.

2. Scalping screen followed by a picking table. This is a preferred system, since it removes the fines and thus facilitates picking.

3. Rotary screen-type breaker, which accomplishes both a reduction to a certain top size, depending upon the size of perforation, and rejects the hard rock—or at least that portion of it larger than the perforations. Normally, where rotary breakers are employed final cleaning is done in mechanical equipment.

4. Conventional screen to accomplish the same result as that attained with the rotary screen-type breaker.

5. Roughing cleaner to throw out the major part of the heavy material and prepare the feed for the final units. Fines may be bypassed around the roughing unit, while large lump usually is processed by hand picking. Preliminary breaking may also precede roughing with a mechanical cleaner. A further refinement is hand picking to remove coarse, heavy material, followed by breaking and roughing.

Raw-Coal Sizing

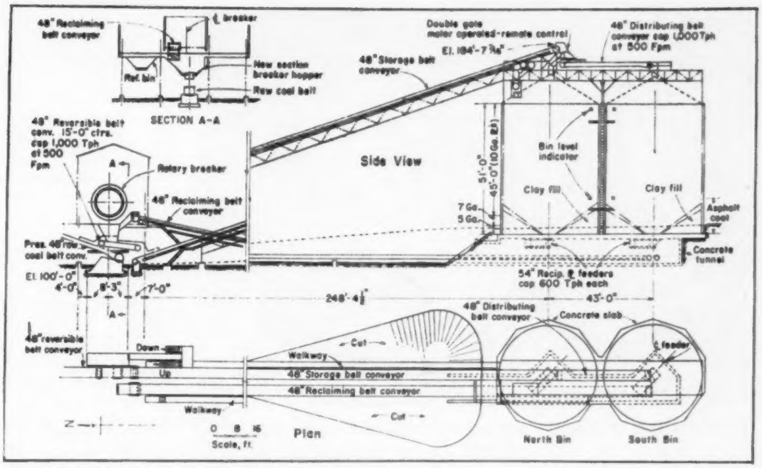
THE SHAKER SCREEN, inclined at approximately 15 deg and with a crank or eccentric drive providing a stroke of around 6 in and a speed of 100 to 120 strokes per minute, is the common type of raw-coal sizing device. It is receiving increased competition, however, from vibrating screens, usually of the mechanical type.

A major difference between the two types of screens lies in the fact that the shaking unit also can be employed to convey and distribute the products, including provision for hand picking, as in plants preparing by hand picking and screening.

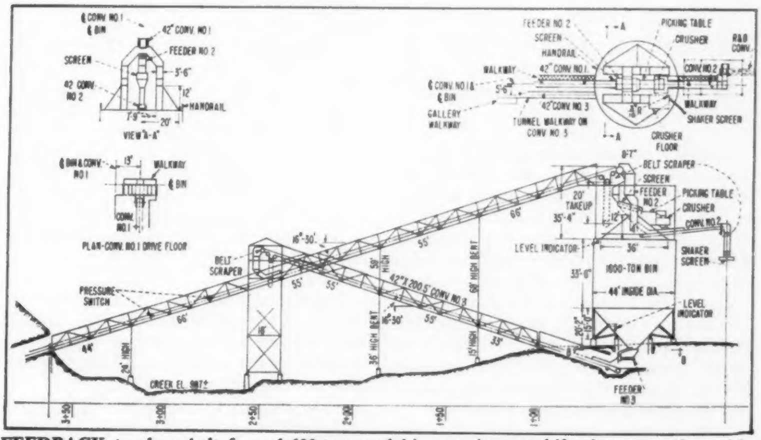
A second difference between the two types of screens is the fact that the vibrating type, though it cannot do conveying, provides higher capacity in a given space in many instances. Degradation with either depends upon type of coal, type of screen and method of operation.

FLEXIBLE SUSPENSION—The flexible-arm or Parrish-type screen, usually operating at 150 to 185 rpm, 5- or 6-in stroke, 2- to 5-deg slope, is another form of shaker. However, its major use is more for final sizing and dewatering, especially in the anthracite field, where it is widely used for this purpose.

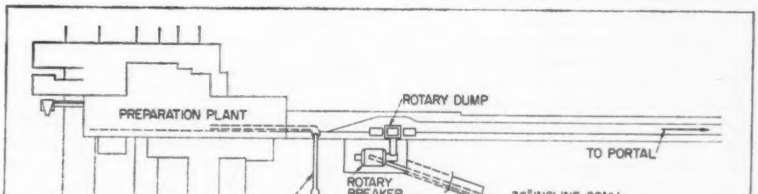
Carrying the flexible-suspension idea still further, a new shaker employs wire ropes instead of hanger boards or rods. Consequently a minimum of stress is transmitted to the structure. This is made possible with a new-type drive. The screening units may be sin-



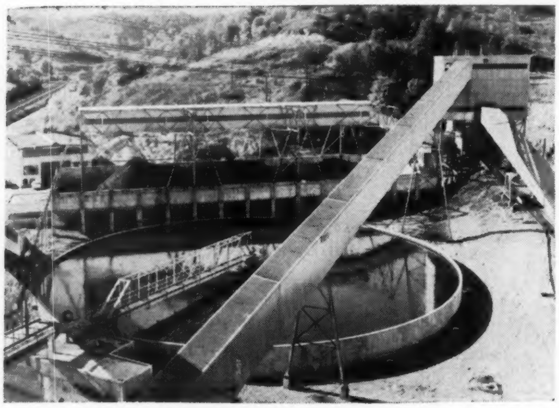
TWO STEEL SILOS with clay-filled corners, preceded by a rotary breaker, provide 3,000 tons of storage at a strip operation in addition to 1,000 tons in the dump hopper.



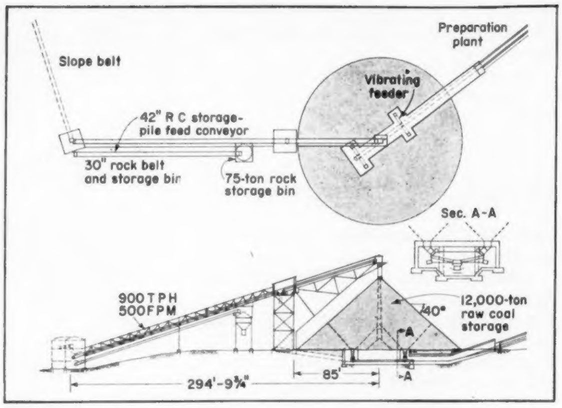
FEEDBACK to slope belt from 1,600-ton steel bin permits one-shift plant operation with two-shift mine-operation.



GROUND STORAGE here involves rough cleaning, distribution to two funnel-shaped pits by boom conveyor, and reclamation by feeders to subway conveyor.



OPEN-TOP HOPPER fed by tripper belt provides capacity of 15,000 tons of raw coal. Multiple feeders permit blending



IN-LINE RAW-COAL setup for new mine, with motorized telescopic chute, provides for 12,000 tons of storage in coal-flow route.

gle or double. In the latter the opposed units discharge to a common center chute.

Screening Factors

In addition to inclination, speed and length of stroke (or amplitude with vibrators), some of the factors affecting screening results are:

1. Depth of bed. Since screening can be accomplished only when the smaller sizes work their way down to the plate, depth of bed, in conjunction with size of opening and square footage of screening surface, is a major factor. With large openings depth of bed may be greater. With smaller openings, bed depth must be reduced or the area of screen surface must be increased. Time on the screen also is a factor, though the oppportunities for increasing it are somewhat limited. Where it is increased degradation and breakage tend to increase with it.

2. Degradation. As previously noted, time is a factor in degradation. Narrow shakers also tend to increase degradation, and there is a major increase when more screen surface is provided than is necessary to accomplish the desired separation.

3. Wear. Heavy loads, coarse material and the possible presence of considerable rock are factors in wear on raw-coal screens. Among the answers for vibrating equipment is heavy alloy wire or alloy plate. On sh k-ers, types of plate used to reduce wear include cast manganese.

For a detailed discussion of screen design and operation, see the *Coal Age* Operating Guide, "Coal Screens and Screening," April, 1960, p 107.

Hand Picking

FROM THE STANDPOINT of impurity removal, hand picking normally is effective only on coal 3 in or larger in size. Hand picking may also be employed to improve appearance by removing off-standard material.

Under reasonably good conditions, where the impurity content is high, one picker can remove as high as 6 tph. Under average or poor conditions with a lower impurity content, production may drop to 1 to 2 tph.

Picking Equipment

Picking facilities include belt and apron conveyors, shaking tables and, occasionally, chain conveyors, the latter normally being employed only under special conditions and where the impurity problem is a minor one. All conveyor-type units lend themselves to combining the table with the loading boom.

The flat-topped apron conveyor and the shaking table best meet the major goal of removal of impurities without lifting or other handling beyond sliding the material removed to the discharge point. Other types of conveyors normally require skirtboards and thus necessitate lifting each peice to remove it.

The flat table may be a part of the shaking screen or may be separate. The shaking table also lends itself readily to degradation removal by the installation of a screen section at the discharge end.

Some shaking tables have been equipped with partitions or deflection plates to further ease the load on the pickers by making it possible for them to do no more than push impurities out of the main stream to the center or pull them to the side.

Washing

WHAT ACTUALLY HAPPENS in the separation of coal and impurities is a complex and to some extent unknown physical process. Particle size and shape are involved, as well as the resistance of the medium used to movement of particles through it, and the fact that coal is cleaned as a mass of particles, with consequent interference between free movement of particles within the cleaning medium.

Since the ideal condition for separation of coal and heavier refuse is a still bath of the proper gravity, and since the true or artificial solutions come closer to this condition, the sharpness of separation is increased. This has led to growing use of heavy mediums and solutions—sand and water, magnetite and water, calcium chloride and others.

Other factors which may favor the use of a heavy medium include more-than-normal irregularity in quality and quantity of feed; a need for changing gravity from time to time; and operation at less than 1.45, where baths without upward currents theoretically offer the best conditions for a sharp separation, though capacity per square foot of area may be reduced.

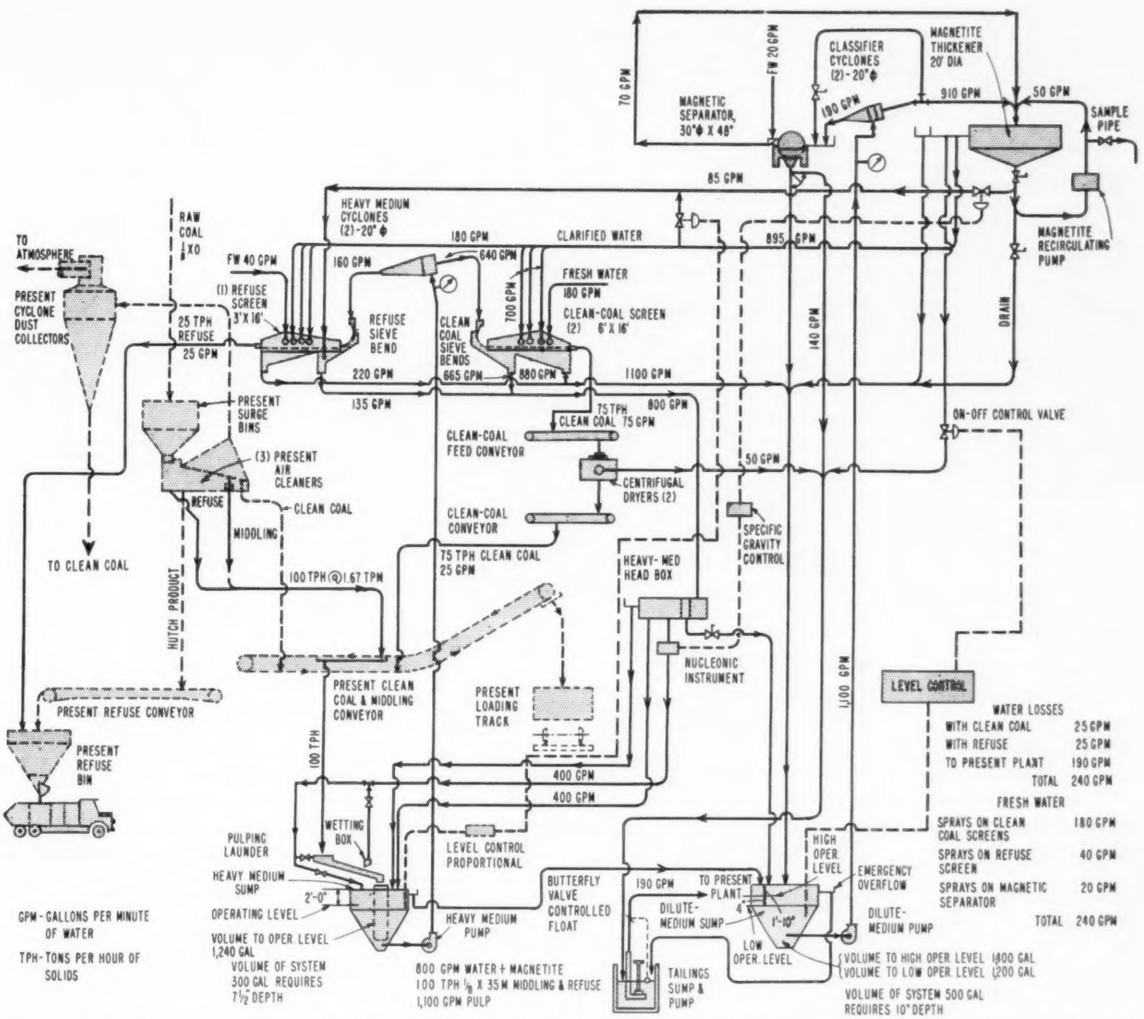
GAGING SEPARATION DIFFICULTY—A good indication of the difficulty of separation is the amount of material in the raw feed that lies close to the gravity of separation. In other words, the greater the percentage of near-gravity material, the more difficult, as a rule, the separation. A good indication of the efficiency of a cleaning operation is the quantity of misplaced material—coal in the reject and reject in the coal. To apply this measure, however, the inherent ability of the cleaner itself to separate coal and refuse must be known, since cleaners vary in their ability to achieve a given separation. Evaluation of this ability is a somewhat complex process, but methods of achieving it include those in "Evaluating Preparation Results," *Coal Age*, April, 1950, p 80.

Where it is evident that the problem may be difficult and the maximum in efficiency is desired, it may pay to wash sizeable tonnages in pilot equipment or actual going plants to check test results. The results of washing a new coal may also be predicted by mathematical or statistical methods, such as that described in "How to Predict Results of Washing a New Coal," *Coal Age*, June, 1952, p 98.

Washing Practice

SIZE SPREAD IN FEED—Certain types of washers require a rather small range in the size of the feed. Examples include the mechanical jig, classifier-type units, and certain washers using heavy media. The emphasis in design in recent years, however, has been toward equipment that will handle a rather large range of sizes—for example, the air-pulsated jig and the usual heavy-media equipment. The latter, incidentally, is now offered for handling a top size of feed ranging to 12 to 14 in.

Even where the washer is designed to take, say, all coal from 6 in down to zero, and can frequently do a good job on all the fractions in such a feed, some compromise must be made. Consequently, if tonnage is fairly high and a sharper separation is desired throughout, the practice is to install



HEAVY-MEDIUM CYCLONES handle cleaning in this 1/8x0 fine-coal plant, which also employs cyclones and thickener in the magnetite circuit, plus nuclear-type controls for automatic density regulation. Level controls also automatically regulate liquid flow in the magnetite and cyclone circuits.

separate units for the coarse and fine fractions—for example, one for 6x1 or 4x1, and a second for 1x0. Where the equipment requires a closely sized feed, the only out is to install separate units for each fraction it is desired to clean.

BY-PASSING FINES—Fine coal, say ¼ in or less, may be by-passed around washing equipment (1) to keep it out of water and thus avoid the ensuing drying and handling complications, (2) to permit more efficient operation of washing equipment installed to handle a rather wide size range, and (3) because of the problems involved in mixing of fines with medium, such as, sand and magnetite. The fines may be subjected to further treatment in other equipment or, if both their quantity and ash content are not too great, may be mixed back into the washed coal.

UNIFORM FEED—A uniform feed, both in quantity per hour and in impurity content, adds measurably to the efficiency a washing unit can reach. The best method of attaining uniformity in quantity is the installation of some form of surge hopper or bin, plus a mechancial feeder, ahead of the washing unit. Attaining uniformity of impurity content is normally achieved by some form of blending equipment, as discussed previously.

Feeding faults with jigs especially include the following:

1. **Overloading**—More tonnage than the unit can handle.
2. **Unbalanced feed**—More material to one side than to the other.
3. **Segregation**—One side or the other receives the bulk of the fines.
4. **Bad transverse distribution.**
5. **Interruptions**—Stopping and restarting a jig or other washer usually affects results materially.
6. **Fluctuations**—These, plus interruptions, are held by some authorities to warrant very substantial expenditures in raw- and clean-coal storage.
7. **Screen-plate troubles**—Loose plates or screens with holes can break up stratification and result in complete plugging.

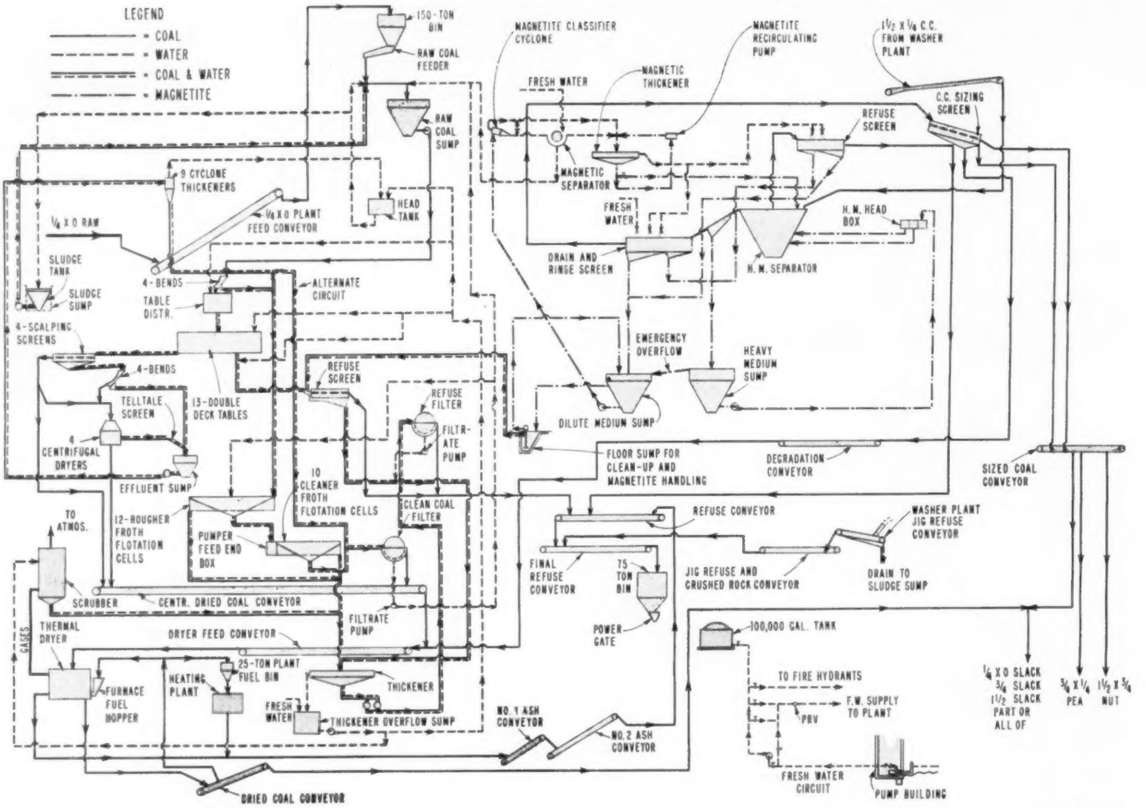
FEED CONDITIONING—Prewetting either in the feed chute or on special prewetting screens facilitates separation when the material reaches the washer.

Fine Coal Washing

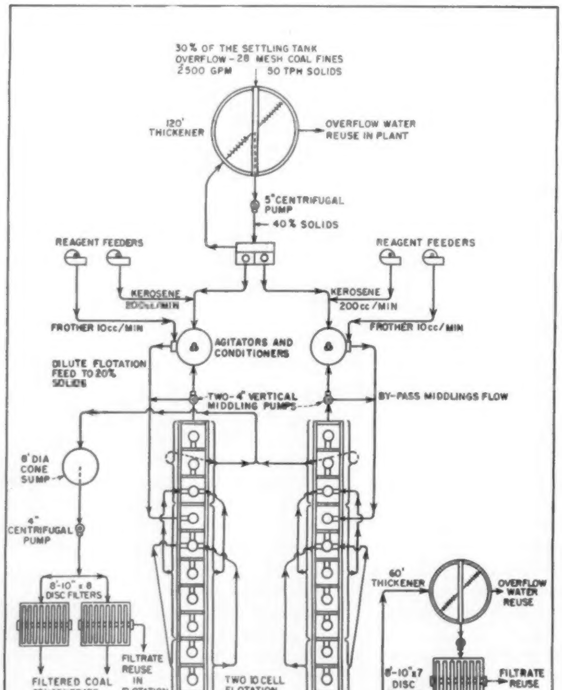
FINE-COAL UNITS—Equipment now used for coal from, say, ¼ in down to around 28M or 48M includes the following:

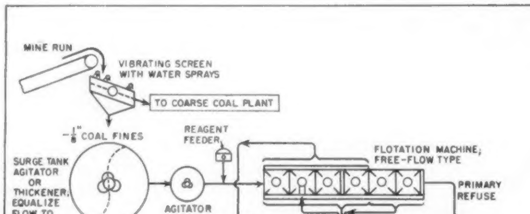
1. **Continuous upward-current** washers.
2. **Washing tables,** including new double-deck units that double capacity in the same floor space. The importance of proper feeding is reflected in the number served by feed distributors.
3. **Fine-coal launders.**
4. **Fine-coal jigs.** Such jigs have found rapidly increasing use for both virgin coal and middlings from other types of cleaners. Feldspar is used as the bed in the most-recent of the fine-coal types.
5. **The heavy-medium cyclone,** which also can handle coarser sizes—up to approximately 1¼ in.

Advantages cited for the cyclone include



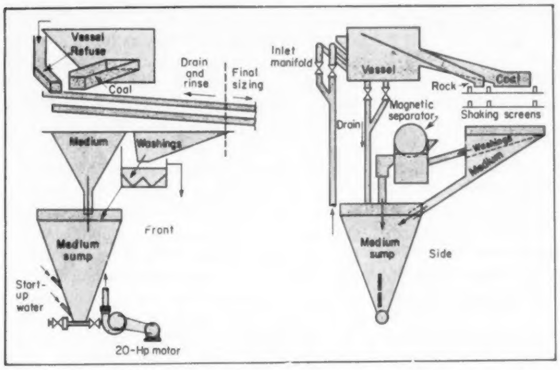
PNEUMATIC LIQUID-DENSITY CONTROLLERS automatically regulate specific gravity in this plant employing conventional H. M. separator, plus tables and flotation for 1/4x0. Cyclones, centrifuges, filters and thermal equipment handle thickening and dewatering.



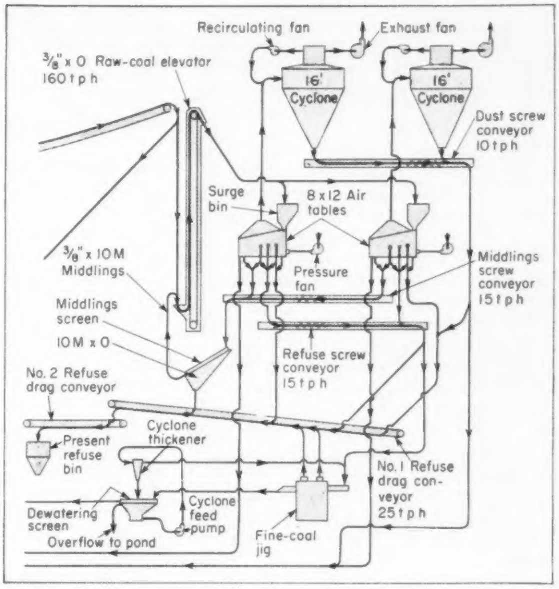


COAL UP TO 1/8 IN is treated in this flotation setup using machines designed for the service. Clean coal, refuse are filtered and thickened, and tailings can be tabled or jigged.

FLOTATION SETUP for minus 28M coal using parallel flotation machines with middlings retreatment and following up by filtering both clean coal and also refuse fraction before final discharge.



SIMPLIFICATION OF THE MAGNETITE CIRCUIT is attained in this design by combining rise-and-drain with final screening.

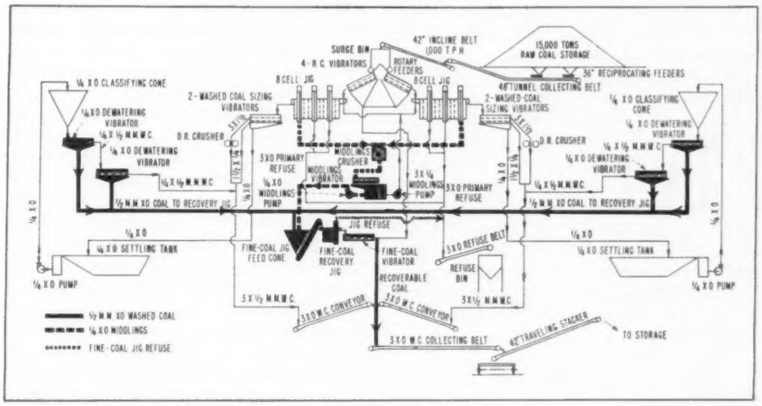


RETREATMENT OF MIDDLINGS from air cleaners is the function of the fine-coal jig in this flowsheet for 3/8x0

much less plant space, easy arrangement in multiple units separating at different gravities, no effect on sharpness of separation as a result of variations in load and raw-coal composition.

6. Flotation units, discussed in more detail later in this section.

Classifiers and centrifuges might also be considered fine-coal cleaners on occasion. This results from rejection of the extreme-fine fraction which might carry the bulk of the ash.



FINE-COAL FLOW to new jig includes ½mmx0 from dewatering screens plus ¼x0 middlings. Sizes are blended in feed cone before passing to jig. Two jigs process 25 tph each of coal containing 25% ash.

Media Handling

MEDIA CONDITIONING—Reclamation and treatment of the media used in heavy-media systems is necessary for at least two reasons: recovery of an expensive material that otherwise would be lost, and preservation of the proper gravity of the bath in the cleaning unit.

Reclamation systems installed today normally handle medium in two parts: (1) a normal- or near-normal-concentration fraction derived from unloading on special screens or sieves, including the increasingly used bent type, or on special unloading sections on regular rinse-and-drain screens, and (2) a dilute fraction derived from rinsing the coal after preliminary unloading of the magnetite. Usually the normal-concentration fraction goes to one sump while the dilute fraction is concentrated by a magnetic separator, or a separator plus other units.

The simple circuit therefore comprises, after unloading and rinse-and-drain, heavy- and dilute-medium sumps and a magnetic separator returning thickened magnetite to the heavy-medium sump or directly to the washing circuit. Even greater simplification is attained in one circuit shown in an accompanying illustration. The dilute medium goes directly to the magnetic separator from the rinse-and-drain screen, which also is the sizing screen. The separator in turn feeds to the single medium sump supplying the washer.

More-comprehensive circuits are exemplified in two flowsheets for fine-coal plants accompanying this discussion—one plant with heavy-medium cyclones for washing and the other employing conventional H.M. equipment. Both plants are provided with heavy- and dilute-medium sumps, and in both the magnetic separator is preceded by cyclones and followed by a thickener. The thickener provides magnetite storage when the system does not require replenishment, as indicated in the cyclone flowsheet. In both plants high- and low-level controls in the medium sumps control the volume of water in the cyclone and medium-circulation circuits. In the cyclone plant, tailings from the separator are pumped directly to mine disposal; in the H.M. plant they are first thickened and filtered for disposal with cleaner refuse.

DENSITY CONTROL—Manual checking of vessel gravity and addition of magnetite as necessary is relied upon in many instances, but the trend is to automatic controls for more-precise and uniform results. Both nuclear and pneumatic equipment is employed.

Use of the nuclear type, in this instance measuring the density of the medium in the pipe from a heavy-medium head box, is illustrated in the accompanying cyclone-plant flowsheet. When it signals that medium is necessary a valve is opened in the thickener-underflow circuit to let concentrated magnetite return to the dense-medium sump line and head box.

Dip tubes working on air pressures are installed in the separator in the H.M. flowsheets. Changes in density are pneumatically transmitted to a density controller actuating an air-operated needle valve in the thickener-underflow line.

Froth Flotation

As coal and refuse particles get smaller and smaller, their ability to move as desired through water or other washing medium becomes less and less until a point is reached where separation cannot be accomplished on the usual basis. The practical line of demarcation is somewhat indefinite, although the minimum so far suggested for heavy

media, for example, is 1 mm, with ½ mm as a possibility. At that point, somewhere around 10M or less, a different principle of separation must be employed to get maximum efficiency with reasonable capacity.

Flotation achieves these goals.

Two flowsheets showing, in one instance, the conventional setup for minus 28M coal, and in the other matte-type equipment for minus ⅛, are reproduced in the accompanying illustrations (*Deco Trefoil*). In the 28M installation, retreatment is achieved by returning the discharge of certain cells to cells earlier in the series.

The minus ⅛ installation is an example of a relatively simple flowsheet which accomplishes efficient recovery at a low ash content. The coarser fraction facilitates subsequent dewatering. Primary refuse is screened at 35M, and the plus 35 is retreated in a secondary flotation unit, followed by screening of the tailings and final treatment on a table. All the refuse is collected in a thickener for water reclamation. The underflow may be filtered if required or desired.

SIMPLIFYING WATER CIRCUITS—Various method of using flotation equipment include cleaning of drag-tank or classifier products, as well as the products of cyclones handling dirty water (see accompanying schematic flowsheets from *Wemco Notes*). In fact, flotation now is being employed to simplify and reduce the cost of cleaning up water, with coal recovery as an added but secondary benefit. Even without the revenue from coal recovery, proponents of this use of flotation argue that the capital investment and operating costs are reduced compared to those for large thickeners, filters, etc., though their use is not eliminated completely.

Desliming, Desilting

Since leaving the extremely small size in the raw feed frequently reduces efficiency in cleaning the fine sizes of coal, in addition to adversely affecting drying, the trend today is to deslime or desilt prior to cleaning or drying. Desliming or desilting equipment includes cyclones, hydraulic classifiers, hydroseparators, bowl-type desilters and radial screens (*Coal Age*, February, 1959, p 112) as well as conventional screens and other equipment. A fuller discussion of desliming appears in the "Dewatering and Drying" section later in this feature.

Aspiration

Although one time employed to a limited extent for dedusting stoker coal, aspiration has hitherto found little application in coal preparation. Now it is being increasingly considered as another means of getting the fines (16M and down) out of the raw feed to washing equipment or out of the final shipped product. Aspiration thus becomes an alternative to desliming, and though the dust still must be handled, proponents of the system argue that it may be less complicated and cheaper than getting it out of water on the scale that otherwise would be necessary.

The dust may be discarded, recombined with the washed and dried coal in loading or, in one scheme, fed to a fluidized-bed dryer as fuel.

Air Cleaning

THE BASIS of cleaning with air is substantially the same as cleaning with water or other mediums (see preceding section). Air, however, eliminates or reduces the drying problem, although it involves a dust-handling problem similar to the water-handling and clarification problem involved in wet washing.

High-ash and high-sulphur impurities are removed completely but there is practically no bone separation with air as the medium. The lower limit of cleaning with the most-used type of unit today is about 48M. There is no improvement in ash below this size but at the same time all the finer coal is available for mixing with the clean coal, meaning 100% recovery without the sludge and dewatering problems accompanying wet washing.

Air cleaners normally operate on a fairly closely sized feed and, as with water, the feed should be uniform in quantity and as nearly uniform in impurity content as possible. Moisture variations are particularly troublesome in air-cleaner operation.

The majority of the air cleaners installed today operate on coal ½ in or less in size, though larger coal is treated. From the standpoint of the drying problem, washed coal over about ¼ or ½ in may be dewatered sufficiently for acceptance without special equipment—at least in many instances—which is part of the reasoning leading to the installation of combination wet and dry plants. And if mine conditions or mining practice make drying of fines desirable, it may be accomplished to the advantage of the air-cleaning process by predrying. Normally, 2 to 2½% surface moisture in ⅜- or ¼-in coal is about ideal.

Most air cleaners now installed are three-product machines, and thus normally provide a middlings product for retreatment. The goal in this middlings production and retreatment is maximum efficiency in separation with minimum loss of coal values. Dedusting to remove up to 50% or more of the fines—usually 48M—adds significantly to normal air-cleaning efficiency.

Dust Collection

Equipment for dust collection includes the following:

1. Cyclone collectors. These centrifugal units are a popular means of removing dust from air. Since single units handling large volumes are less efficient because of reduced air velocity, multiple and tandem units are offered, raising separation from, say, 85 to 95%, up to 98%.

2. Turbo-centrifugal collectors. Turbo-type units, usually termed "clones," offer the advantage of smaller size as a general rule. Like the standard cyclones, they are relatively inexpensive to buy, are easy to operate and are low-maintenance units.

FINE DUST—Even at 98% separating efficiency, the quantity of very fine dust that can still escape to the atmosphere can run up to several tons per day. To trap the most of the remaining fine dust, cloth or bag-type and wet-type collectors are employed.

Cloth collectors. Of the cloth-type collectors, the bag type was one of the first to be installed at coal-cleaning plants, normally with a shaking device to remove the accumulated dust. A more recent development is the cloth-screen collector, which provides larger capacity per unit of space occupied, is easier to inspect and maintain, and is provided with an improved cloth-shaking device. To prevent interruptions while the dust is being shaken off the units, dual-unit, or continuous cloth collectors may be installed, the air being directed alternately from one to the other.

Exhaust operation of dry-type equipment keeps the dust within the ducts and equipment in case there are leaks. Acid, abrasion and the like are factors to be considered.

Wet collectors. Wet-type collectors include the tumbler; a combination of turbo-centrifugal unit and water sprays; and the hydrostatic. All have the advantage of high capacity in relatively small space, in addition to a high separating efficiency as a result of the use of water.

Retreatment

STEPS in the retreatment of coarse coal are as follows, starting with a product from the primary washer draw or a special middlings draw:

1. Preliminary screening of the product at 2 in or other limit.

2. Crushing of the oversize to the screening limit to release the impurities.

3. Recirculation of the crushed product to the washer or to a separate retreatment unit. Separate retreatment units are employed where several units handle primary cleaning or where, even after crushing, the recirculated product contains considerable material close to the washing gravity.

With the smaller sizes, particularly less than, say, about ¼ in, where crushing is often less effective as a means of releasing the coal values, the entire draw product may be recirculated or retreated in a separate unit. This is particularly true in air-cleaning coal under approximately ½ in.

Salvage

EXAMPLES of salvage operations include the following:

1. Crushing and washing of pickings, either in regular or special units.

2. Picking out, crushing and loading separately for steam coal a bony product that might otherwise go to refuse.

3. Processing of roof brushings, track cleaning and the like to recover a regular or a steam-coal product. Normally, the production of such material should be sizable to warrant separate facilities.

Recovery from primary washer reject also, as a rule, involves preliminary screening to take out fines and crushing to release interbedded material, although the reject may be treated as it comes from the primary units. The latter, however, usually is less efficient and does not give as good a recovery.

Clean-Coal Sizing

CLEAN-COAL SIZING or classification, is handled by both shaker and vibrating equipment, the latter having made substantial gains in this field as well as in the field of raw-coal sizing.

For a complete and detailed discussion of equipment and methods, see the *Coal Age* Operating Guide, "Coal Screens and Screening," December, 1959, p 105.

Accuracy

Aside from moisture and blinding, accuracy involves time the coal is on the screen surface, and also cloth or plate wear. Time on the screen brings in the question of breakage, or degradation, which increases with increased screening time, though as in anthracite, the hardness of the coal may permit a longer retention time without increase in breakage.

Other things being equal, sufficient time must be provided to permit the smaller sizes to work down and be separated out, and in turn this brings in the question of bed thickness. It should not be excessive if good screening is desired, and the smaller the opening the less the bed thickness should be if excessive length of screen is to be avoided. Where one of the products is screenings and the feed to the unit includes all sizes up to lump, depth of bed should not be more than 4 to 6 in, and screening efficiency and capacity may be increased by placing a large-hole relief screen on the slack section.

In getting fines out of coarser material and in facilitating separation in the lower ranges, wet screening is frequently employed. "Washing" in "pools" at intervals along the screen and fitted with sprays is a growing practice, along with dams, special stepped screen sections to turn material over, and so on.

SCREENING EASE—The relative ease or difficulty of screening a certain feed at a certain size, which in turn is one measure of the screen area necessary for accurate separation, reflects in the main the quantity of near-opening material in the feed. If there is a substantial percentage of material at or slightly larger than the opening size, particles smaller than opening size find it more difficult to work down through the bed of near-opening material, and also there is a greater chance that particles only slightly undersize will be carried beyond the screening surface before they have an opportunity to go through. The difficulty increases as the size at which screening takes place decreases.

Screen Wear

Plate, cloth and wire wear reflect load, screening time, abrasive nature of the material, corrosion if the water is acid, and the material used in the screen. Where plain-steel plate is employed, increasing the thickness is one way of offsetting the effects of wear but brings a significant decrease in screening efficiency. Consequently, operators turn to bronze and alloy steels, with stainless coming rapidly to the front in recent years for the smaller sizes. With round-rod or wire screens, or with special-profile bars, wear is largely on the top and consequently the period of reasonable accuracy is materially lengthened.

Rubber screens and rubber-clad perforated plate are among the new types created to combat wear.

Small-opening punched plate must be relatively thin, both to facilitate the punching operation and because excessive thickness, as previously noted, affects screening efficiency. Consequently, additional support is required to prevent sag and wear. Bars under the plates are the preferred method. An alternative is the Perister-tread screen—a stepped-type unit in which the risers provide the extra support while the screening is done on the treads. Bars or other supports also are installed under the cloth on vibrating screens.

SPECIAL SCREEN OPENINGS—Elongated openings frequently are employed instead of round or square. Among the goals are: (1) increased screen capacity, (2) reduced blinding and (3) less breakage with friable coals. However, replacing conventional screens with long-opening units, with no change in the effective width of opening, normally increases the size of the through product.

A special form of screen is the lip type, usually with a greater width at the lower end of each opening. It provides a tumbling effect and this together with the type of opening, normally results in an increase in capacity of up to double or more. At some plants this characteristic has resulted in installation of lip screens to offset a condition of chronic overload. Incidentally, over-loading severely affects screening efficiency. For maximum accuracy, feeders or other devices should be provided to insure uniformity in rate of feed to screens.

Use of elongated, lip and similar screens brings in the factor of separation by shape as well as by size. Consequently, the products are quite different in character, with considerably more flats in the underproduct with the elongated-opening units.

Blinding—Cause, Elimination

Blinding in coal screening occurs with all sizes but is particularly annoying and most affects efficiency with the smaller material. Blinding reflects in the main the percentage of particles near the size of the screen opening and especially, as the size of the coal decreases, surface moisture.

Additional factors tending to increase blinding include overloading and the presence of clay and shale mud. As a rough rule, a surface moisture of 6% will result in complete or nearly complete blinding at separations of ¼ in or smaller. At 2% or less, little or no blinding occurs.

Aside from blinding, moisture also tends to increase the inaccuracy of screening by causing small particles to stick to larger pieces. Where washing is done, one of the functions of sprays on classifying screens, in addition to opening up and agitating the bed to facilitate separation, is washing the fines off the large pieces and through the screen. "Pool washing," as previously noted, is one means of facilitating this operation.

The building up of a film of moisture and packed fine material is held to be the major cause of blinding in fine-coal screening. Time is a second major factor. Rust and corrosion with plain steel also especially after the screen has been idle can cause major blinding difficulties, for a time.

Electrical heating is rapidly growing as a means of preventing blinding of screen cloth. Other methods applying to cloth, plate or both, include:

1. **Alloy metals** which resist wetting and film buildup.
2. **Use of plate,** wire and cloth impervious to or less subject to rusting and corrosion.
3. **Use of large openings,** though this brings in the risk of throwing more oversize into the through product.
4. **More screen area** or a lower feeding rate with higher moisture.

More fundamental, perhaps, are mixing and blending to achieve uniform surface moisture or predrying of moist or wet material.

Dewatering, Drying

BECAUSE THE SURFACE AREA on which moisture can collect increases rapidly with reduction in size, dewatering presents a greater problem with fines. As a rough rule, natural drainage will reduce the moisture on coal above ½ in and perhaps down to ¼ to a point where there will be little or no freezing except in very severe climates. However, it may be desirable to reduce the moisture still further. Below ½ or ¼ in, in the absence of some other form of treatment, freeze prevention requires specific dewatering methods and equipment.

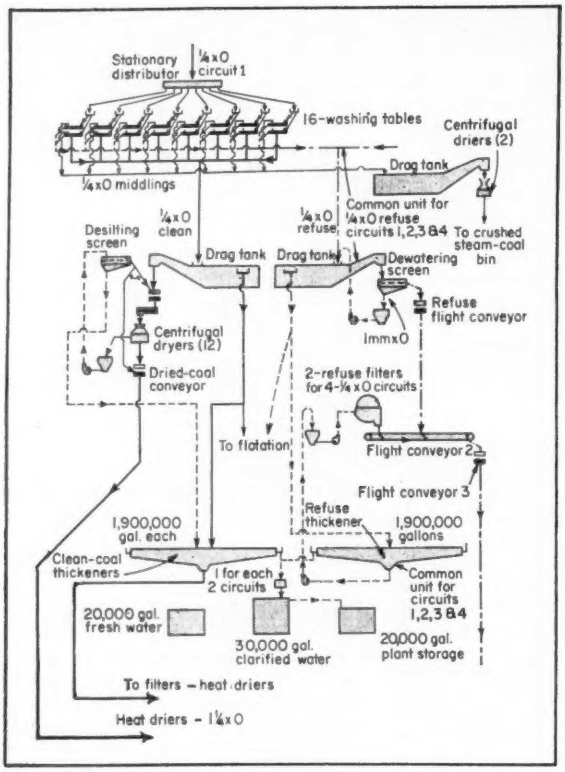
Natural Drainage

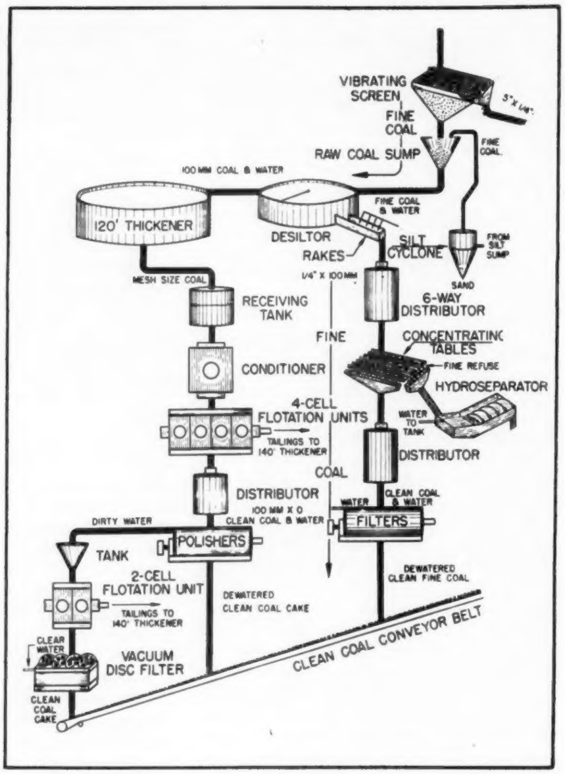
Equipment employed in dewatering by natural drainage includes hoppers and bins; inclined and horizontal conveyors with screens in the bottom; perforated bucket elevators; and fixed screens. Fixed screens in flumes from washers to classifying screens, in fact, are widely used for unloading a large part of the water.

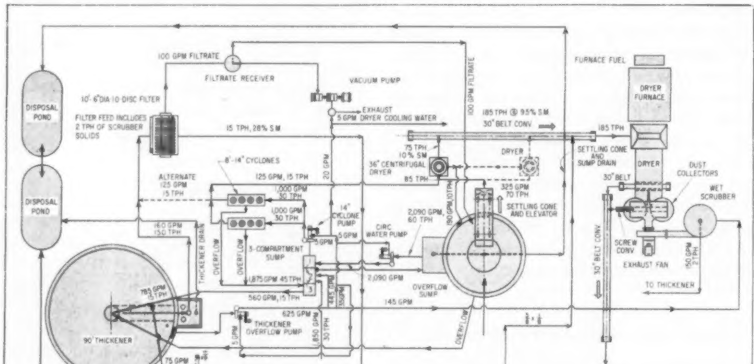
The fixed-screen principle for unloading or reducing excess water has been developed into special types of units both here and abroad, including the launder or riffle screen developed for anthracite (*Coal Age*, December, 1959, p 119).

"Radial" and "bent-sieve" stationary screens developed abroad are finding increasing use in the U.S. for various applications. The radial type is employed, for example, in removing silt from sand used in cleaning. It also can be used for screening and for dewatering prior to other drying.

The "bent-sieve" unit is employed for desliming and dewatering either by itself or in conjunction with other equipment. One application is shown in the cyclone-washing flowsheet in the preceding "Washing" section. Advantages of these stationary screens, and others doing similar jobs, are high productivity per foot of floor and screen space, low or no power requirements, and a substantial reduction in investment for final screening and dewatering facilities.







COMPREHENSIVE SYSTEMS for coal drying and water handling as exemplified by three recent installations involving most of the equipment employed in modern plants of today for maximum recovery and conformity with pollution regulations.

Mechanical Dewatering

Omitting such processes as thickening and the like (see later section), mechanical dewatering is done by screens, centrifuges and various forms of filters. With all these units, the dewatering process, as with fixed screens, normally involves producing a through product which must be loaded wet, discarded or treated by other means. Also, the overproduct, depending on size, and other factors, may be further processed in other types of equipment.

SHAKER SCREENS — Conventional shakers of course accomplish dewatering, but when dewatering is the specific goal the tendency is to go to special screens, usually flexible-board-hung or supported and operated at speeds of 150 to 400 rpm, with short throws of around 1 in.

Plate or cloth may be used in dewatering the larger sizes, and plate also is employed for a substantial portion of the smaller sizes in anthracite. In bituminous, however, when dewatering at, say, 28M, the tendency is to use cloth, rod or wedge wire.

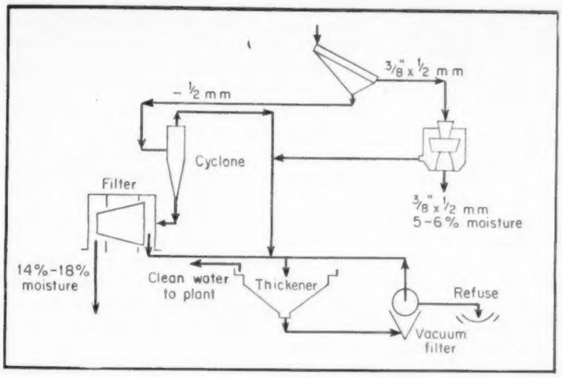
When used for dewatering, the shaker-type screen normally will reduce the surface moisture of sizes above approximately ¼ or ⅜ to 5% or less. When dewatering smaller sizes at, say, ½mm or 28M, surface moistures of as low as 3% have been obtained, but the range usually is 5 to 10% and higher.

VIBRATING SCREENS — When used within their limitations, vibrating screens provide real advantages in the field of dewatering. Initial, operating and maintenance costs are low, and a high removal of solids from wash water is achieved with a minimum of effort. Since operation in a nearly horizontal position is necessary, it usually is desirable to have a high operating speed and a stroke at an acute angle with the screen deck to facilitate the conveying action, which normally is slightly uphill.

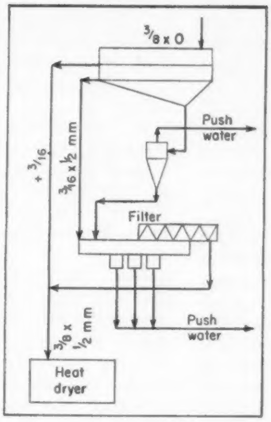
Width and length of screen should be selected for proper handling of the expected quantities of water and solids. Openings as narrow as ⅛mm can be employed in some instances but the usual lower limit is ¼mm. Special attention to keeping the width narrow enough to maintain a bed at all times is required. Dams in the center and at the discharge end help both in maintaining a bed and in promoting water removal through longer retention of the coal on the screen. However, dams should not be high enough to result in excessive bed thickness.

The bulk of the water should be removed on the first half of the screen for best results, and a bed of the requisite thickness should be formed as soon as possible to prevent excessive loss of the fine sizes. Unloading of as much water as possible before the coal is placed on the screen helps, and if fine sizes from some other unit are added they should be placed gently on top of the bed after it is formed. Size distribution of the primary feed should be such that it will form a bed.

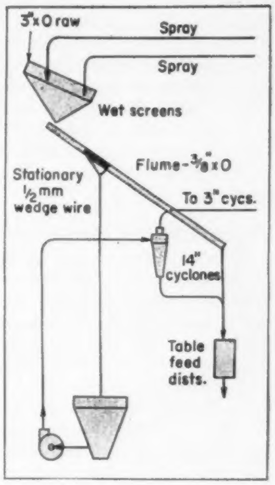
Dewatering results reflect size of coal handled. Where the average size of the feed is



SOLID-BOWL HORIZONTAL CENTRIFUGE supplements vertical unit in this circuit also including cyclone, thickeners and vacuum filter for refuse.



HORIZONTAL VACUUM FILTER in this flowsheet is preceded by cyclone. Filter product goes to thermal unit for final drying.



SIMPLIFIED DESLIMING ahead of tables by fixed screen.

around 5/16 in, a surface moisture of 5% normally can be attained, and in many instances much less. Final moisture increases with reduction in size up to 25% or more with, say, 28 or 48M material.

CENTRIFUGAL DRYERS — Equipment of the centrifugal type commonly used in coal preparation includes the following:

1. Vertical units with transporting facilities.

2. Vertical units without transporting facilities, using water or vertical vibration to move the coal. Units using vertical baskets and vertical vibration handle coal up to 1¼ in, in size with minimum degradation and up to 98 to 99% recovery.

3. Horizontal units with vibration, also handling coal up to 1¼ in with similar results.

4. Horizontal solid-bowl type. Recovery of ⅜ or ¼x0 is 95% or better. Final moistures are somewhat higher than with other types in many instances, though comparable results have been achieved with desliming. An accompanying flowsheet shows one method of employing this unit, as well as vertical equipment plus cyclones, thickeners and vacuum filters in a circuit for ⅜x0.

In terms of actual water removed the centrifuge ranks high as a low-cost device, providing a total cost of between 5 and 10c per ton of cake. Degradation in operation must be expected with some types and under some conditions. Depending upon type, size offered and other factors, surface moistures as low as 3% are possible with stoker and 5 to 7% with minus ⅜ or ¼.

FACTORS AFFECTING CENTRIFUGAL RESULTS—The size of the fines fraction affects the results of centrifuging in much the same way as it affects the results of other forms of drying. As an example, solid-bowl units have produced surface moistures of 10 to 13% where the slimes have been included in the feed. In another plant, the same unit, with 60% of the minus 200M material removed from the feed, achieved a cake moisture of around 6%.

Maintenance also has a major bearing on the results of centrifuging. Proportions and clearances are carefully designed for maximum efficiency. Frequent maintenance, rather than letting renewable parts run to destruction, keeps the moisture in the output at a minimum and thus increases acceptability without further treatment or makes the cost of subsequent thermal drying appreciably less.

FILTERS—With the increase in pressure to reduce stream pollution, and also as a result of the growing use of other types of mechanical dewatering equipment producing effluents containing fine material, there is an increased trend toward the installation of filters of the continuous-vacuum type. As a corollary, a solid-bowl centrifuge especially designed for the service, known as a "polisher," is used for the same purpose.

FINAL MOISTURES—With the vacuum type, flocculation of the fine-coal particles by means of caustic starch or some other agent increases filter capacity and reduces moisture in the final cake. For a report on how flocculation increases filter capacity and how to select a flocculant, see *Coal Age*, December, 1957, p 74.

Final surface moisture of the filter product is held to reflect largely the moisture in the feed, the percentage of minus 200 to 325M material and the ash content of the dried product, though feed moisture apparently is less of an influence than the other two factors. Depending upon percentage of fines and ash, surface moisture in the product ranges down to as low as 15% and up to approximately 30%, with some exceptions both above and below. For a complete discussion of selecting and operating disk-type filters, including factors affecting filtration rate and moisture removal, see *Coal Age*, January, 1955, p 76.

AUTOMATIC FEED CONTROL—The accompanying diagram shows the automatic feed-flow control used at one plant to get a full cake at all times, prevent recirculation of solids, relieve the operator for other duties 90% of the time, and attain uniform cake moisture (*Coal Age*, October, 1957 p 106). Differential probes in the underflow sump, conditioner and filter tub control valves which in turn control slurry flow.

Thickening and Desliming

Since large volumes of water complicate the final drying job—whether in mechanical or heat equipment—and since very fine material decreases the capacity and efficiency of both mechanical and thermal units, the trend today is toward thickening or desliming, or both, in advance of drying, as well as in washing, as noted previously. Aspiration for dry removal of fine dust (16M or less) is now being introduced as an alternative to desliming.

THICKENING—Reducing the water load on the final drying units may be done by relatively simple means, common ones being fixed sieves or mechanical or electrical screens—usually both—ahead of the drying unit. For even greater water removal, plus also desliming, the equipment that may be employed includes settling tanks, drag tanks, thickeners and cyclones, which may be preceded—and usually are—by fixed sieves and operating screens for unloading.

The cyclone has the advantage of low cost and high flexibility. The settling tank also has the advantage of relatively low cost and simplicity but the degree of thickening may not be as great. Sedimentation in relatively still water is perhaps the ultimate in thickening, and is the province of the usual circular thickener. To speed settling or to take care of conditions approaching colloidal suspension, flocculation may be employed.

Examples of how most of the units previously mentioned are used are included in many of the flowsheets in this preparation guide.

DESLIMING—Removal of very fine material prior to further drying may be done as the first step in the fine-coal processing cycle, or directly before the material to be dried goes into said dryer. Removing clay slimes, as an example, ahead of froth flotation keeps reagent consumption low. Removal of extreme fines ahead of tables is another growing practice.

Examples of desliming in various types of

circuits may be found in several of the flowsheets included in this section. Equipment includes the riffle screen, standard vibrator, settling cones, drag tanks, bowl-type desilters and cyclones, as well as classifiers of the hydraulic and rake types. In some instances, as in conditioning feed for tables, the drag tank frequently employed may be replaced by a simple stationary screen in a flume (see diagram).

WARM-WATER PROCESSING — Water is easier to shake or spin off when warm. Advantage is taken of this fact at one plant (*Coal Age,* December, 1955, p 70), where dust is removed from the dryer exhaust by a combination of cyclone collectors, and water sprays are used to cut down the speed and volume of the exhaust to atmosphere. Two cyclones are provided for each of the four dryer exhausts, after which the gases go to a concrete duct leading to a silo chimney.

Sprays in the concrete duct reduce gas temperature from approximately 180 down to 110 F. The warmed water, with its temperature raised about 45 F, is returned to the fine-coal washing circuit, raising its temperature by up to 13 F in winter. This warmer washing water and resulting warmer coal facilitates mechanical dewatering, apparently by reducing surface tension.

Heat Drying

Heat drying is about the only way to get surface moistures of as low as 2 to 3% consistently, particularly with the finer sizes.

DRYER TYPES—Types of heat dryers used in coal mining are:

1. Rotary, with either inner and outer shells, or an outer shell with lifting vanes inside. Newer type units are designed for outdoor operation and coal-dust firing.

2. Reciprocating screen, which also acts as the carrying medium.

Top size varies from as low as ⅛ with the fine-coal units up to 2 or 2½ in. Depending upon size of the unit, and also the size of the coal, capacities of screen-type driers normally range from 25 to 125 tph of dried product.

3. Cascade, in which the coal flows down in steps. Units employing the cascade principle usually are fitted with revolving shelves or trays in a round vertical shell.

Depending upon type and design objectives, dryers of this type handle coal with a top size ranging from ¼ or ½ in up to 2 in, with some more suited to handling certain size fractions, such as, 2x½.

4. Conveyor or carrier, in which the coal is moved through a hot-gas chamber on a perforated carrying strand or a wire-mesh belt. One type provides two stages of drying with both up- and down-draft gas flows.

5. Suspension, also known as "flash," in which the coal is introduced into an upward-flowing gas stream. These dryers are widely used on coal ½ or ⅜x0—sometimes down to 10M or less. One recycles part of the stack gas to the furnace to keep down oxygen content and maintain an inert atmosphere in the dryer. In a second type, part of the dried product can be recirculated if feed moisture is naturally high or as a result of a high percentage of fines. A special trap is available for the latter unit for friable coals. Both also include provision for burning the dust from the cyclones or secondary separators.

6. Fluidized-bed, in which the coal is dried in a reactor in a fluid state. Though originally developed for a top size of ½ in, the units now are employed on sizes up to 1¼ or 1½ in. This type of dryer presently has a wide lead over all others.

DUST SUPPRESSION—Dust is a problem with practically all heat dryers, and particularly with those handling the smaller fines. Cyclones are the first line of defense and may be supplemented by bag-type collectors, wet collectors and water-spray systems (see "Air Cleaning"). High temperatures and high moistures in the spent gas have militated against the use of bag collectors in some instances and resulted in adoption of wet or wet and dry (tumbler-type) collectors.

DRYER SAFETY — Ten recommendations by the USBM for promoting safety in the operation of heat dryers (R.I. 5198) are:

1. Good housekeeping should be stressed to prevent spread of combustible dust and eliminate ignition sources. Adequate vents should be provided, not only on cyclones but on other equipment and in the main structure of the plant.

2. Automatic controls—preferably with alarms—should be provided to shut down equipment if the temperature rises excessively, coal feed is interrupted or gas flow is interrupted.

3. Moisture content of the coal feed to the dryer should be maintained at a uniform level.

4. Temperature charts should be carefully watched and dryer operators should not tamper with equipment or controls.

5. Controls, valves and other sensitive parts should be inspected frequently.

6. Equipment should not be operated beyond rated capacity and definite upper limits should be placed on permissible inlet and outlet temperatures and the rate of coal feed.

7. Scrubbers and collectors should be placed beyond the cyclones to prevent excessive discharge of dust.

8. Adequate fire protection and firefighting equipment should be maintained in the drying plant.

9. Long ducts, and especially horizontal ones, should be avoided to minimize ignition hazards and reduce surfaces on which fine coal can accumulate.

10. All dryers, conveyors and other dust-producing equipment and transporting machinery should be made as dust-tight as possible and operated to prevent dust leakage.

Crushing

ALTHOUGH CRUSHING or breaking for market purposes can take place in the preliminary processing, as in reducing the top size in the mine-run feed to a certain dimension, the majority involves specific sizes after hand picking or other cleaning and the goal usually is the production of stoker or other smaller sizes. An exception is anthracite, where practically all of the breaking is done in one or more stages before the coal goes into the cleaning units.

In bituminous plants, a favorite place for cleaned-coal crushing equipment is between the top and bottom strands of the mixing conveyor. This permits a wide flexibility in the sizes that may be run to the crusher, and also provides a convenient means of getting the crushed product back to the loading point, especially when the product is loaded without further sizing or other treatment.

Crushing may be—and frequently is—a part of a breaking and rescreening cycle for the production of double-screened stoker or other sizes, such as pea (see "Rescreening").

FINES LIMITATION—A major goal in clean-coal crushing operations—or, in preliminary breaking for the same purpose—is reduction to the proper size without excessive production of fines. Crusher design is one answer, and types and models now available permit good attainment of this objective. Operation is another answer and, among other things, involves stage crushing with rescreening between each stage. Some plants use as many as three or four crushers in series with vibrating screens between to unload the fines, which otherwise would result in increased grinding and pulverizing.

Rescreening

THE VIBRATING SCREEN, normally receiving its feed from the main sizing shaker is the most-used type of rescreening unit in the bituminous fields. Rescreens also are quite commonly hooked up to receive material from cleaned-coal crushers when the natural output of the mine is not sufficient to meet stoker and other specialty demands.

Mixing, Blending

MOST of the mixing is done in the old reliable mixing conveyor. Unless crushing is introduced into the circuit, the mix is a natural one—in other words, the sizes in the mix are present in the percentages that naturally come from the final sizing screen.

"Prescription" mixing is a relatively new method of achieving a size consist in line with the customer's desires. A major advantage is that consists can be absolutely accurate and absolutely uniform.

Prescription mixing normally is limited to the smaller sizes designed for industrial or domestic-stoker use. It involves placing the various sizes in separate bins. The sizes may be as they naturally come from the sizing units, or they may be produced in part or entirely by crushing and rescreening. Mixing normally is achieved by feeding the sizes onto a gathering belt ending in a boom section. The rate at which the sizes are fed out of the various bins establishes the percentages in the mix. This rate may be adjusted by adjusting gate openings, but is considered less accurate than special feeders equipped with variable-speed drives.

Dustproofing

THE PRINCIPAL MATERIALS used for dustproofing coal are oil, calcium chloride and special chemical compounds, usually containing calcium chloride with other substances added. Calcium chloride and other materials pick up water from the air and thus provide a moist surface to which the dust adheres. Corrosion-inhibitors may be added to the chemical-type dustproofing agents to prevent possible attack of metal firing equipment and coal-handling parts.

Spray oils for dustproofing are available in a wide range of characteristics to fit the job being done. Equipment for applying them includes both heating equipment for spraying hot, and high-pressure atomizing, or "cold-oil" equipment for spraying cold. With the hot-oil systems, the oil-carrying lines may be paralleled by heating lines carrying steam or hot oil to keep the oil at the proper temperature.

QUANTITY AND TYPE—Quantity of material necessary to achieve a desired degree of dustproofing depends upon both the size and type of coal being treated. Since the treatment is a surface job, and the surface to be treated increases as the size of the coal decreases, more material must be applied to the finer sizes. Porosity and other mechanical characteristics of the coal also influence both quantity and type of dustproofing material. With some very porous coals for example, good treatment with an economical quantity of petroleum-base material requires going to a very-high viscosity to prevent absorption of the material into the interior of the coal. Most of the high-volatile coals, however, may be treated satisfactorily with oils having a viscosity of around 200 deg.

APPLICATION—For maximum effectiveness with a minimum quantity of material, dustproofing material should be applied while the coal is in the air. Use of properly designed hoods prevents waste and insures maximum treating efficiency. Normally, such hoods are placed at the ends of loading booms or chutes, but they may also be placed over conveyors and other equipment, particularly those handling the larger sizes. The proper design of nozzle and the proper temperature at the point of application are key factors in the use of hot oil, and nozzle design is likewise important with other types of material to insure good treatment with minimum material quantities.

Regulation of material flow to the flow of coal may be accomplished by such steps as paddle-controlled valves at the ends of booms and chutes. The position of the valve is controlled by the thickness of the coal stream and in turn increases or decreases the flow of dustproofing material, preventing both overtreatment and undertreatment.

Freezeproofing

WHERE HEAT DRYING is not the practice and mechanical drying does not provide sufficient moisture reduction to prevent freezing, the coal may be treated with chemicals or oil. Such treatment usually is required with slack, screenings and other small sizes. The need for treatment is affected not only by the climate encountered but by industry custom and customer preference.

Salt and calcium chloride, usually applied dry, are the two main chemicals used for freeze-proofing. The quantity depends upon the expected temperature and the moistness of the coal. For calcium chloride, the Calcium Chloride Institute offers the following guide:

	Lb CaC1 per Ton at Specified Temperatures, Deg. F.		
Moisture	+32 to +15	+15 to 0	0 to −15
3%	3.0—4.5	4.5—6.0	6.0—7.5
6%	6.0—9.0	9.0—12.0	12.0—15.0
9%	9.0—13.5	13.5—18.0	18.0—22.5

Chemicals may be thrown into the car by hand or may be dispensed by mechanical feeders into the coal stream as it is loaded. The latter normally provides more uniform and more accurate treatment.

Oil is finding increasing application as a freezeproofing agent. One operation, as an example, (*Coal Age*, February, 1956, p 75), uses an 80-sec oil at the following rates: ¼x0 centrifuged carbon, 6 qt per ton; 4x2 or 2x1¼ crushed to 1¼ or ¼ in, 2 qt; 1⅞x28 M mix, 3.4 qt. In loading coal under 1¼ in in size, the inside of every hopper is sprayed with 6 gal of oil for a 50-tonner and 7.6 gal for a 70-tonner.

Loading

ANTHRACITE is loaded into railroad cars almost entirely from storage pockets, reducing the number of loading tracks to one or two for many plants. Early bituminous practice was to provide a track for at least each major size. Now, as in anthracite, the bituminous trend is toward loading on as few tracks as possible. Methods of reducing the number of loading tracks to a greater or lesser degree include:

1. **Storage pockets.** Such pockets, receiving coal by conveyor, may be above or below the normal loading point. Thus, a second size—stoker as an example—can be loaded.
2. **Two-way chutes.** Dual conveyors, as an example, deliver two sizes to two-way chutes, one for each track. By combining through gates, the number of sizes to the two tracks can be increased to three.
3. **Elevated shuttle belt.** Where only one size is loaded, or where storage facilities are provided for one or more additional sizes, loading of up to an entire shift's run can be done without moving a car once the trip is set in (*Coal Age*, March, 1953, p 94; October, 1957, p 76).
4. **Automatic shuttle belt.** In one example of the use of this equipment, the belt is mounted between parallel tracks. Empties are placed on one of the tracks and the belt travels from one to the other, loading them in sequence. It then switches to the parallel track and works back while the loads are being replaced with empties. If there is a gap the belt will continue to travel along one side and cross over to the other to try to find an empty. If it can't it shuts the plant down—automatically—until empties are placed.

CAR HANDLING—Mechanical retarders provide positive control of car movement in loading, and there is a growing trend toward the use of motorized equipment, including special hoists which permit pulling a car back uphill if desired, or moving it back and forth several times to load the coal in layers.

Hoist-type retarders, incidentally, save overshooting and runaways, and consequently eliminate delays ranging from several minutes up to, where a column may be knocked out, several days.

Automatic dropping and loading of cars is now coming into the picture. At one of the first installation (*Coal Age*, June, 1958, p 94) the system involves hoists with double ropes and sensing switches to control car movement, transfer of coal flow from one to another, and uniform loading without the attention of an operator.

Gravity and electro-pneumatic retarders are employed in another system with varying degrees of automaticity. In one such installation (*Coal Age*, February, 1959, p 118), some 720 tph is loaded on one track. At another (*Coal Age*, July, 1959, p 80) one man at the dump controls the spotting and loading of some 20 to 30 cars an hour on four tracks.

Labor Savers. Where full automaticity is not possible, providing car droppers with bicycles, electric jeeps and other types of wheeled equipment save walking time and labor and make them more effective.

Clean-Coal Storage

Stockpiling clean coal is a growing practice at bituminous mines, as well as anthracite. The favored place is on the ground, though some silos and bins are employed. Bin capacity ranges up to 2,000 tons or better; ground capacity, 250,000 tons or better. With large stockpiles, belt equipment is used in almost all instances for both stocking and reclaiming, with the reclaiming unit usually placed in a subway under the stockpile.

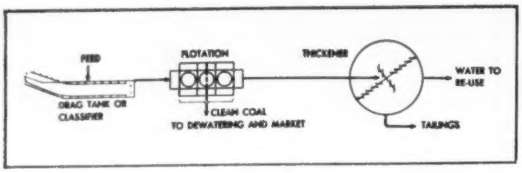
Piles may be single conical, laid down by a fixed-discharge conveyor; curved, laid down by a pivoting stacker conveyor; double conical, laid down by separate piling booms fed through a flygate, or by a reversible stacking belt; or long and narrow, laid down by a belt with traveling tripper. Lowering spirals or ladders are employed to reduce breakage where piling booms are not employed.

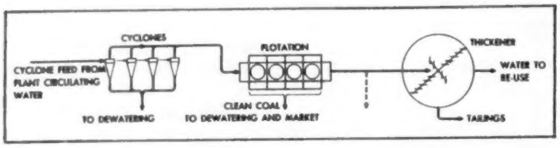
For a detailed discussion of prepared-cone storage and loading facilities, see the *Coal Age* Operating Guide, "Mine Storage of Coal," December, 1960, p 105.

Truck Loading

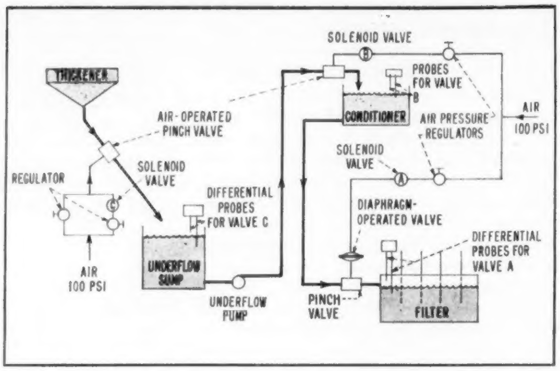
It is possible to load trucks over the tracks or by chutes brought out from the plant but this, among other things, makes it impossible to service trucks except when the plant is running. Consequently, the usual practice is to provide bins or pockets for sizes sold to truckers. Spiral lowering chutes prevent breakage in filling bins holding the coarse sizes, and degradation in handling through the bins is removed by fixed screens in chutes, or by small shakers or vibrators.

Late truck-loading plants include, in the

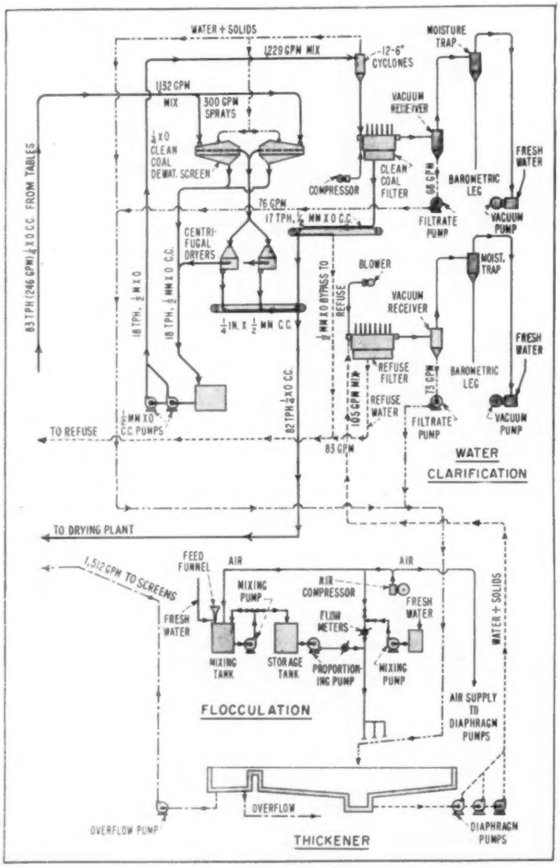




TWO EXAMPLES of the use of flotation for handling material from settling tanks and cyclones, the latter exemplifying the application of flotation units to simplify the water-clarification circuit.



WATER-CLARIFICATION CIRCUIT at one new property involves a combination of cyclones, thickeners, centrifuges and vacuum filters.



AUTOMATIC FEED-FLOW CONTROL for filters employs a combination of probes and valves to achieve uniformity in results

bituminous field, a multiple-silo installation in which the coal is distributed to the pockets by a pivoted elevated belt, which is swung on a curved track from one pocket to the other for filling purposes. Trucks are loaded through chutes.

Barge Loading

Barge-loading plants fall into about five classes, as follows:

1. A simple dock from which trucks dump into the barge at times when water conditions permit.

2. The stationary-chute type, which is simple and low priced and works well where river fluctuations are not too great and banks are steep.

3. Elevating-boom type, with barges moved back and forth in the river beneath. The elevating boom allows more loading time if river elevation changes greatly. This type is advantageous where the bank of the river is considerable distance from the channel and the elevating boom and conveyor belt can be combined for travel across the flood plain.

4. Floating-barge type, with the loading boom mounted on a floating, or spar, barge and pivoted for easier loading. Requires a steep bank or fill to permit retraction and extension of the main conveyor with changes in water level.

5. The tripper-conveyor type, in which the barges are stationary and the loading chute moves back and forth to load and trim. Nothing has to be done to the barges but load them.

For examples of most of these types see (*Coal Age*, December, 1956, p 58; also October, 1956, p 60; June, 1957, p 74; January, 1958, p 76).

TRAMP-IRON REMOVAL—Removal of tramp iron is handled at a number of plants, even though all sizes are washed, by suspended magnets or magnetic pulleys at the point the raw coal enters the plant. If washing or removal in the raw-coal stage is not practiced, iron removal should be done in the loading stage, especially with coal designed for stoker use. Facilities include magnets designed for use in the bottoms of loading chutes, as well as other types of units.

DEGRADATION REMOVAL — See "Clean Coal Sizing."

Water Handling

QUESTIONS involved in water handling at plants cleaning by wet methods include:

1. Fresh-water supply and treatment for plant use.

2. Clarification and recirculation of process water.

3. Final disposal where circuits are or cannot be closed.

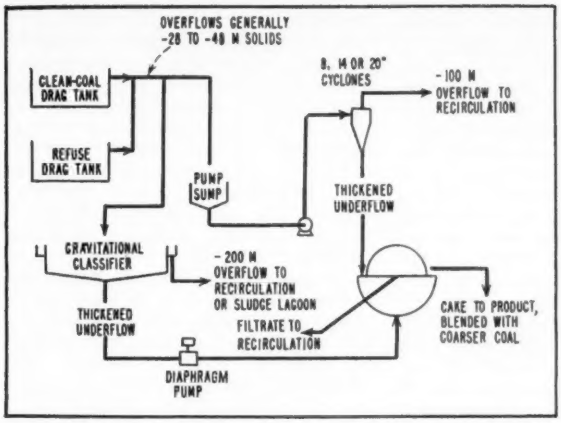
Makeup water requirements vary with the type of circuit. In a fully closed circuit, where sprinkling at the face results in an average of 5% surface moisture on the raw coal, which is the same as the average for the shipped coal, it can be seen that fresh water cannot be added. Normally, the only clear-water applications would be on pump glands and certain other essential applications. In an average plant, under these conditions, makeup water might well be only 50 to 75 gpm. In an open circuit, it might well be several times that minimum.

Sources of makeup water are:

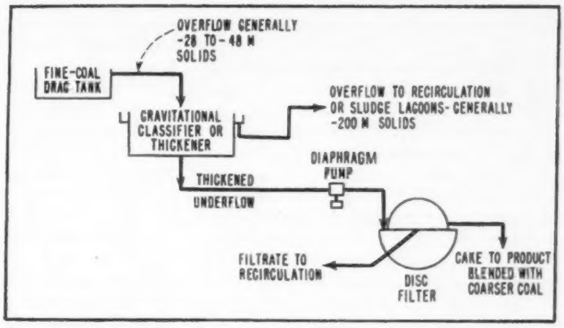
1. Deep wells.

2. Surface water from lakes, ponds and streams, or from reservoirs made by dams to catch surface runoff.

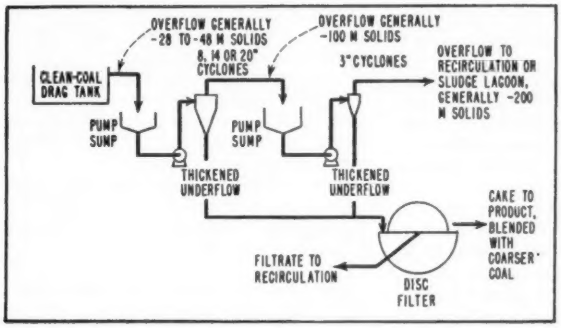
3. Mine water if available and suitable.



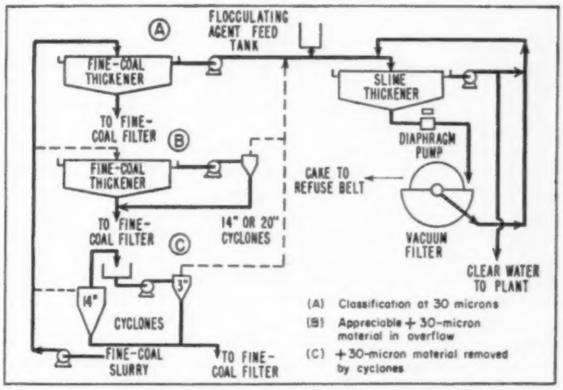
SOLIDS REMOVAL from wash water by flocculation and filtration, with variations to meet varying conditions.



VACUUM FILTRATION with cyclones for preliminary classification of feed.



VACUUM FILTRATION with gravity classifiers or thickeners for preliminary classification of the feed to the unit.



VACUUM FILTRATION with gravity thickeners and cyclones for preliminary classification of the feed before filtration.

TREATMENT—Water from deep wells normally can be used without treatment. Mine water, on the other hand, may be quite acid though there are exceptions. Surface water may or may not be acid, and may at times be contaminated by mud. Some authorities hold that the pH value of the water in the plant circuit should be between 8.0 and 8.5.

Other operators, however, feel that slight acidity is not objectionable. However, if the water is very acid, treatment with lime or soda ash is in order. Treatment permits plain steel for example, to be used instead of alloys, resulting in substantial savings in cost of equipment and materials, in replacement labor and in shutdown time. Even if the makeup is only mildly acid or neutral, acid may build up in the recirculated water and need treatment for that reason alone. Automatic equipment is now available for treating water efficiently and at minimum cost.

Unless there is an assured minimum flow adequate for plant need at all times, storage should be provided to tide the plant over periods of reduced flow.

Handling Wash Water

Stream-pollution regulations and the need, in many instances, for decreasing the loss of good coal to the refuse have resulted in major activity in the processing of wash water. A third reason for processing is to prevent the buildup of solids in water recirculated to washing units, since excessive buildup may materially affect the gravity of separation and consequently cleaning results. Available data indicate that many preparation men regard a solids content of more than 15 to 20% as excessive, while some try to keep it under as low as 5%.

Closed circuits frequently are mentioned as objectives in water handling—and are practicable in some instances though not in all. Reasons for circuit closing include: (1) elimination of discharge to streams, (2) reducing makeup water to that required for pump glands and other essential uses, (3) recovery of coal and (4) recovery of medium. As a corollary of closing, however, it is necessary to remove at least part of the solids, especially if clay and mud are present, to prevent solids buildup and a change in the gravity of the bath.

THE WHY OF BLEEDING—Closing a circuit may either be impossible or not desirable, however. If, as previously indicated, moisture on the coal leaving the plant is equal to that entering the plant, the quantity of makeup water that can be added without bleeding is nil. Thus, even gland-water requirements, if included in the water circuit, can force bleed under some circumstances. Some circuits, however, have been closed successfully, and the trend is more in that direction.

Practice and field custom also may result in bleeding of some to considerable quantities of wash water. It may, as an example, contain large quantities of high-impurity fines that would be difficult to clean. And under some conditions, it may be necessary to feed excess fresh water into the system for essential services, even if it is not required to rinse off clean coal and improve appearance as it might be in some instances.

Also, complete closing in the sense of allowing no escape of either coal or water may become impossible if certain steps are considered desirable in the preparation process—for example, desliming at 325M. The slimes must go somewhere and it is not always practicable to prepare them so they can be put in with the clean coal or the refuse.

Since bleed therefore becomes necessary in many instances, the sludge pond also becomes necessary if discharge of solids to streams is to be prevented. Where employed, the pond should be operated to prevent the overflow of anything but clear water.

In one instance, a baffled concrete tank is employed as a pond substitute (*Coal Age*, January, 1960, p 92). An overhead hoist facilitates removal of accumulated solids as necessary.

SOLIDS REDUCTION—The goal in this operation, in contrast to fairly complete removal to meet pollution regulations, for example, is keeping the solids content of

recirculated water to a reasonable figure; not over, say, 15 to 20%.

Facilities include settling cones, drag tanks, sludge ponds, cyclones and so on.

FLOCCULATION—Where natural settlement is depended upon for removing solids from wash water, results reflect the size of the material, the time provided for settlement, and the degree to which disturbance can be reduced. Flocculation of the material promotes settlement, and some types of thickeners are built to permit flocculation along with settlement.

SOLIDS REMOVAL—Complete removal of solids may be desirable for two reasons: (1) salvage of good coal from the wash water, or (2) conformity with pollution regulations. Where coal is concerned, the same installation ordinarily accomplishes both results. Where refuse is involved, the only goal is meeting stream-pollution regulations.

Settling ponds, where space is available, are perhaps the simplest method of attaining sufficient solids removal to conform to pollution regulations. In some instances, they may be the cheapest, though not always. Their construction involves some expense, and if the capacity is limited they must be cleaned out from time to time. With ponds also, any fines that reach them, if of good quality, are either lost or can be recovered only at some added expense. Consequently, there is a trend toward extracting at least part if not all of the solids from the water before running it to the pond.

Equipment for accomplishing some solids removal before discharge to the pond may be merely the old reliable conical or drag-conveyor settling tank. Other units are thickeners, hydraulic or nonhydraulic classifiers, cyclones, and filters of various types. Combinations also are employed to meet specific conditions.

Flotation. As noted earlier in the discussion of flotation equipment and practices, it is now being increasingly used not only to eliminate solids but also to accomplish this in a simpler less-costly circuit, at the same time recovering saleable material.

FILTER CIRCUITS—Three variations in a solids-removal flowsheet involving flocculation and complete closing of the circuit (*Coal Age*, January, 1955, p 76) are shown in an accompanying illustration. The goals are economical operation and removal of the solids so that they can be handled the same as any other solids, whether coal or refuse. Variation A is recommended where the fine-coal circuit includes a gravity classifier effectively classifying at 30 microns; Variation B, where gravity classification is such that an appreciable quantity of plus 30-micron material is found in the overflow; and Variation C, where the equivalent of two-stage cyclone concentration is employed.

Three water-handling systems based on filters for final recovery of the solids also are shown in the accompanying illustrations. They are suggested for use where clay slimes are not excessive and closed-circuit operation can be obtained by filtration, or where the large slime fraction is bled off to a sludge pond. The three systems involve:

1. Cyclone classifiers in conjunction with gravity classifier or thickener delivering thickened underflow for filtration.

2. Cyclone classifiers in conjunction with filters. The two-stage system shown may be employed (1) where solids under 100M are too high in ash to be included in clean coal and (2) all underflows from both stages are filtered as clean coal. A buildup of minus 100M in the circulating water is prevented in both instances.

3. Thickeners and cyclones for preliminary concentration. Better filter operation is one of the advantages.

How filters are used in a circuit also including dewatering screens, thickener with flocculation, and cyclones is shown in another illustration. The system functions on ¼x0 and the final products are clean coal, refuse and clear water to the raw-coal shakers or to overflow. Thermal drying completes the job (*Coal Age*, October, 1957, p 76).

WATER CIRCULATION—Head tanks with automatically controlled pumps provide a uniform head on washing equipment, with consequent increase in the efficiency of separation, particularly with jigs.

Handling of casual and spillage water is simplified by proper design of the basement floor, which should be equipped with drains leading either to the pond or to a recirculating-water sump. Cleaning up by washing down is facilitated by such construction.

Sludge Recovery

NORMALLY, water clarification and the recovery of fine coal go hand in hand, although if clarification only is the goal the material may only be routed to the refuse bank, particularly if it is refuse in fact. However, the percentage of material finer than, say, 10 or 28M, may be substantial at many plants and may warrant recovery for its own sake.

The equipment for recovering sludge from wash water, as noted in the preceding section, includes: settling cones and tanks, and thickeners and filters, along with hydraulic and nonhydraulic classifiers and cyclones. Cleaning equipment includes flotation units and special fine-coal washers, followed by normal dewatering and drying.

The preceding envisions recovery of the sludge as it is produced in the plant. Another form is recovery from old silt or sludge ponds or banks. Recovery equipment includes conventional shovels and also floating dredges. At some installations, the final step consists of drying. A modification, where the nature of the material warrants, is centrifuging to throw out the fine impurities and then heat drying. Where cleaning is considered desirable, a number of large plants have been built for froth flotation.

Refuse Disposal

THE DUMP TRUCK has taken over a large part of the refuse-disposal job in the coal industry today. Its advocates cite low cost and maximum flexibility, especially where it does not have to surmount too-heavy grades. The aerial tramway lends itself not only to disposal in what might be called normal territory but also to taking refuse across hills into neighboring valleys and the like. The side-dumping or revolving larry, in addition to ordinary situations, also is used to build out from hilltops or hillsides from bins fed by belt conveyors, tramways and the like.

Pumping of refuse is growing, though the question of taking care of the water to prevent stream pollution comes in. In some instances, it has been possible to pump into old mines or worked-out sections. The pumps will handle rather large pieces but normally pumping requires crushing to a top size of 2 or 3 in. Usually top size is held to not over ¾ or 1 in by prescreening or crushing, keeping down line velocity and cost.

Even where pumping is not involved, it may be economical to crush, particularly where large rock is involved. Jaw or gyratory crushers may be indicated under such circumstances. Benefits of crushing include easier handling, a more compact pile and greater ease in maintaining a running surface where trucks are used.

Where refuse output is large, and especially where trucks and similar equipment are employed, a bulldozer for spreading and compacting may pay off.

FIRE PREVENTION—Prevention of firing of refuse dumps has been the subject of considerable research in recent years, and the spread of automotive haulage has made possible new and effective methods of piling, compacting and sealing refuse to practically eliminate firing. One method of layering, compacting and sealing against air is described in *Coal Age*, June, 1951, p 91. Development of the method also was accompanied by steps to extinguish an old fire by stepping, trenching and filling and covering with earth as conditions dictated.

POLLUTION PREVENTION—New and more stringent pollution regulations now make it advisable to place refuse so that no solids can be washed into streams; also, if possible in view of the tightening of regulations, no acid.

Power

VOLTAGE—Accepted voltage for most of the stationary motors in preparation plants is 440, leaving in most instances only the question of whether 2,300 V should be used for certain large units, such as pumps, crushers and the like. A rough rule is that motors of 100 hp and larger should be 2,300.

TRANSFORMER LOCATION — Packaged substations with oil-filled transformers are available for outdoor service, with nonflammable units for indoor. Outside is the place for the transformer station if the highline voltage is over 10,000 and the reduction to 440 is made in one step. If the supply voltage is less than 10,000, the packaged indoor substation with nonflammable transformers is the general choice.

CONTROLS—Starters grouped in factory-assembled control cabinets are now standard for preparation plants. One central cabinet is satisfactory for a small plant, but a large plant may require cabinets at several locations to keep the motors reasonably close to the starters. Draw-type starters which can be pulled out for quick replacement are coming more and more into favor.

Dust is one of the major problems in location and operation of starting equipment. The best solution seems to be one or as few control rooms as possible made fairly airtight and fitted with blowers to maintain a slight positive pressure inside the rooms. Air forced into the rooms should be filtered.

CAPACITORS — The induction-motor load of the preparation plant produces a low power factor, which adds to the bill and heats conductors and motors. Capacitors should be installed in the plant to bring the lagging power factor up to unity. Theoretically, an appropriate capacitor should be placed at each motor. However, practical limitations of cost, space and maintenance generally make it advisable to group the capacitors in the control room.

Maintenance

MAINTENANCE is necessary because of wear and corrosion inevitable in operation, and the effects of the elements, for example:

1. Rusting of the exterior and interior, including structural members and equipment as a result of rain, snow and water.

2. Corrosion from acid water and, on occasion, from the gases given off by burning refuse dumps.

3. The effects of heat and gases involved in heat drying.

4. Wear from the handling of coal and rock.

5. Lack of lubrication, overloading and other abuse, faulty electrical service and the like.

All wear and corrosion cannot, of course, be eliminated. Use of the proper materials and proper designs when a plant is built, or when parts or sections are added or replaced in existing plants, are major factors in maintenance cost. These materials and designs include the following:

1. Location of heavy equipment, particularly of the rotating or reciprocating type, on or as near ground level as possible, cuts structural cost and reduces the effects of weight, motion and vibration.

2. Bracing, steel weight, balancing and damping to provide stiffness, reduce or eliminate unbalanced forces, and prevent the transmission of motion and vibration to the structure.

3. Use of protected steel and special roofing and siding materials, including asbestos-cement, aluminum and stainless steel.

4. Protective coatings and paints for steel exposed to rain, moisture, gases and the like.

5. Neutralization of acid water with lime or soda ash. Automatic feeding equipment now available facilitates this job. Frequently, neutralization will make it possible to get much-longer life from ordinary steel, saving both in material cost and replacement labor.

6. Use of corrosion- and abrasion-resisting materials for screens, chutes, flumes, water lines, pumps and so on, including plastic, rubber and asbestos-cement water lines and connections, and rubber-pinch and orifice-type valves. Stainless steel for bolts, for example, can solve some annoying corrosion problems in certain preparation applications.

7. Use of linings to resist wear and, with some types, corrosion. Examples include glass, tile and brick in chutes; and rubber, plastic, sand-cement and ceramic linings for tanks and cones. Another form of lining is special hard metal for conveyor bottoms. Hard-surfacing of wear points or the use of special wearing strips are natural steps.

8. Use of totally enclosed, splashproof and other special motors for dusty, wet and similar locations, plus moisture- and dust-proof controls or the location of controls in rooms with blowers using filtered air and maintaining a slight positive pressure inside the rooms at all times.

9. Good lubrication with proper equipment and quality lubricants of the correct types applied at the correct intervals. Centralized automatic systems are growing in favor.

10. Regular inspection and cleaning of preparation equipment. Cleanliness and good housekeeping for the plant as a whole naturally supplement these, and to facilitate housekeeping a growing number of plants are being equipped with hoods and covers for certain equipment connected to exhausting and dust-collecting equipment, plus vacuum systems for cleanup.

Quality Control

CHECKING and control measures are both visual and mechanical or chemical. With lump, for example, the bulk and weight of a proper sample, and the increased difficulty of getting a representative sample, make mechanical and chemical tests difficult, and reliance must be placed largely on visual inspection. In washing, visual inspection—by operators who know their business—of the feed and draw material can reveal changes in condition immediately and permit adjustments to be made promptly, although this type of checking is subject to the normal human frailties.

Even with mechanical and chemical methods, the change in conditions takes place before the results are available, thus re-emphasizing the importance of adjusting operating conditions to provide the desired results as nearly automatically as possible. However, even though the data are obtained after the fact, mechanical and chemical tests are necessary to provide positive evidence of whether or not the desired results are being attained and permit adjustment if not.

SAMPLING—Where the tonnage is at all large and a careful check on quality is essential, one or more specialists should be charged with the responsibility of collecting samples. Depending upon the control setup, they also may run sink-and-float tests and prepare samples for more-elaborate chemical tests of the coal.

Number of samples and sampling intervals depend upon control and quality data required. Egg and lump—and perhaps nut and pea—may be sampled at longer intervals and perhaps only once a shift or longer. The problem grows more critical with the smaller sizes, especially where sales are made on a specification basis. As a result, many plants sample stoker and screenings, as examples, at intervals of as small as 15 min, while every hour is fairly common preparation practice.

Automatic samplers installed at transfer points, especially for the smaller sizes, reduce the labor involved in sampling and tend to increase the accuracy. Manual methods include the car sample taken at a number of spots, but the trend today is toward cutting samples out of the coal as it flows into the car. A convenient method is to mount a narrow box of the requisite length and depth on a pivoted arm which is swung through the coal stream.

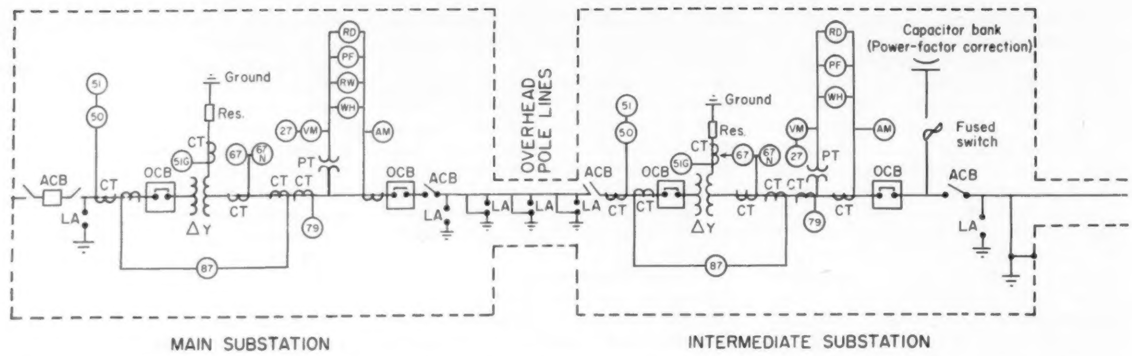
If the sample is intended for chemical analysis in the laboratory, time and labor can be saved by placing the preliminary sample - preparation equipment — crusher, splitter and the like—at or near the point the sample or samples are taken. As an example, some plants have provided platforms alongside the loading booms for sample preparation.

TEST PROCEDURE—Samples for checking cleaner operation normally are processed by sink-and-float. The equipment may be on the cleaning floor or at some other convenient location in the plant. The weight of the sink in a standard sample of cleaned coal is a working indication of how the cleaner is performing. The results also may be converted into fairly accurate ash figures by reference to a curve based on the average results of analysis of a representative number of samples.

Checking the efficiency of washer operation also requires testing of refuse.

More precise results of course can normally be expected by laboratory procedure, although the time interval necessarily is longer. Equally or more important, the laboratory is the only means of attaining all the chemical and physical data on both processing results and the character of the shipped coal, including ash, sulphur, moisture, heat content, fusion and softening temperatures of ash, and so on. Also, the presence of laboratory facilities permits research into suggested changes in preparation procedures and forecasting of results. Therefore, more and more plants are being supplemented by well-equipped laboratories (*Coal Age*, July 1959, p 80, as an example).

RECORDS—The type of records kept for operating and quality-control purposes should provide for putting down the data obtained in a form that will make it easily available to and usable by operators, supervisors and other interested persons. Graphic presentation by curves may be a part of the record system, and the data to be entered may include such things as valve settings on washers. For shipments, the record may show car number, size, ash, sulphur, heat content, moisture and so on.



THE AC SYSTEM includes main and intermediate substations, overhead pole lines, portal control station, section control station, load

Power for Low-Cost Operation

Since 1955

Major increase in the use of AC power underground.

More horsepower built into conventional and continuous mining equipment with subsequent increase in transformer, switchgear and cable capacities.

Power systems designed to provide greater safety and dependability.

Transmission voltages increased from 2,400 to 4,160 and 7,200.

Greater use of power-factor correction to reduce power consumption and increase system efficiency.

Silicone rectifiers gained industry acceptance.

Automatically-controlled AC and DC power systems increased.

Ahead to 1965

Trend toward the use of AC power underground to continue.

Transmission voltages up to 13,000 may enter the picture as concentration, loads and transmission distances increase.

State and federal bureaus may find it necessary to rewrite the electrical code for coal mining.

THE ELECTRICITY required to produce a ton of coal today is approximately 11 kwhr compared to 8.5 kwhr 5 yr ago. Power cost per ton of coal has increased from approximately 12c to about 15c during the same period. These figures represent substantial increases in power consumption and cost. They reflect not only the continued trend to mechanical mining, but to the use of higher-capacity mining equipment as well. The growing list of modern preparation plants with their ever-increasing power loads also have contributed to the rising rate of power consumption and cost.

Power consumption and cost will continue to increase. In view of this fact it is essential that coal companies plan, install and utilize purchased power to achieve maximum service.

Sections in the text beginning with numbers and printed in boldface type are taken from USBM Bulletin 514, entitled "American Standard Safety Code for Installing and Using Electrical Equipment in and about the Mines." The provisions of this code are minimum provisions and are designed to minimize hazards to life and property in and about coal mines. They indicate the steps necessary in the selection, installation, operation, inspection and maintenance of electrical equipment and circuits to obtain proper safeguards in reducing electric shock, fire, explosion and other hazards.

AC Power Systems

ELECTRIC POWER SYSTEMS, whether AC or DC, should be planned to give maximum service. But what is maximum service and how do you get it? The approach to power-system designing necessitates giving several basic factors all the consideration possible to achieve maximum service. These factors include, among other things, the following:

1. Safety.
2. Reliability.
3. Cost.
4. Voltage quality.
5. Ease of maintenance.
6. Flexibility.

2.1.11 ELECTRIC SYSTEM — Electric system means all electric equipment and circuits that pertain to the operation of the mine and are under the control of the mine officials.

SAFETY—Safety features applied to power systems are for the protection of personnel and equipment and also to limit failures which result in lost production time. No one phase of safety should be slighted or overlooked. The outstanding factors of safety standards include:

1. Use of quality electrical components.

2. Simplicity of design.

3. Provisions for adequate short-circuit interrupting facilities properly coordinated to insure selective removal of faulty components.

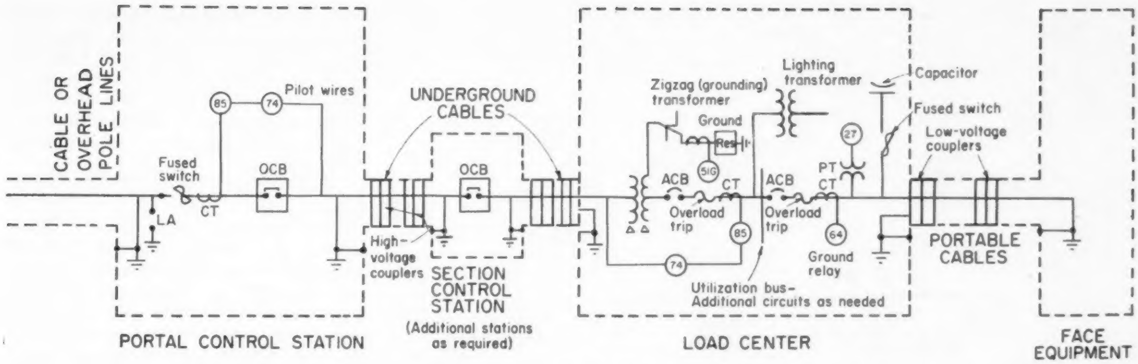
4. Use of metal enclosures for components.

5. Adequate interlocking features for the overall system.

6. Effective grounding for the system and equipment.

7. Good installation practices and proper maintenance.

RELIABILITY—Simplicity of design and the use of adequate high-quality electrical equipment will insure service reliability. The degree of reliability should be consistent with overall economics. And modern-day mining demands reliability because the size of equipment has increased and higher pro-



center and utilization distribution. AC-system components are shown in the above diagram. Standard symbols and numbers are listed below.

ACB—Air circuit breaker
LA—Lightning arrester
CT—Current transformer
PT—Potential transformer
OCB—Oil circuit breaker
Res—Resistance
51G—Time-delay overcurrent ground relay in neutral circuit
87—Differential relay
67—Directional overcurrent relay (phase)
67N—Directional overcurrent relay (ground)
50—Instantaneous overcurrent relay (phase)
51—Time-delay overcurrent relay (phase)
79—AC reclosing relay
27—Undervoltage relay
VM—Voltmeter
AM—Ammeter
WH—Watthour meter
RW—Recording wattmeter
PF—Power-factor meter
RD—Recording demand meter
85—Pilot wire receiving relay
74—Alarm relay
64—Ground relay

ductivity per unit is required to maintain coal's position in today's market. A loss of 8 to 11 tons of coal for each minute of downtime is not uncommon. Consequently, the aim with regard to reliability vs economics should be to achieve 100% reliability. Initial cost may run slightly higher in attempting to achieve this goal but in the long pull reliability will pay off.

COST—Whether a power system is being updated or a new one installed it is better to consider more than one plan. This will aid in providing cost comparisons for selecting a system that meets individual power requirements at the lowest cost.

VOLTAGE—Careful consideration should be given to mining methods and conditions, maximum distance voltage is to be transmitted, and whether the overall mine system will be AC or DC. Normally, the one-step system is employed, with either 2,400 or 4 - 160 V as the nominal transmission pressure. The trend is toward 4,160. And reflecting increased concentration, loads and transmission distances, particularly for cables, 7,200 V is gaining in popularity, with possibly 13,000 at some future date.

Two-step systems are relatively few in coal mining; where they have been adopted the primary voltage usually is 13,000.

Stability of voltage is a measure of the quality of power. Voltage quality is becoming an increasingly important factor. AC equipment at the face is more sensitive to voltage fluctuations. Consequently, volt ge quality must be given full consideration.

MAINTENANCE — Proper maintenance is essential to safety and reliability. The power system should and can be designed to make maintenance easier and safer.

3.5 ELECTRIC EQUIPMENT AND WIRING INSPECTION AND MAINTENANCE—Electric equipment and wiring at every mine shall be inspected systematically as often as necessary to insure safe operating conditions and at least once a month. A report of each inspection shall be made by an authorized person, and a copy shall be furnished to a responsible official and kept on file at the mine. The report shall state definitely the condition of the equipment in each station and substation, of the conductors for each power and lighting circuit, and of the motors and controlling appliances for all electric equipment, particularly with reference to the necessary safeguards and protective features. Equipment and circuits found to be defective shall be taken out of service immediately and repaired before they are used again. A check inspection form is recommended to facilitate making the inspection and report.

At least every 6 mo all grounding conductors shall be inspected for broken connections and each grounding conductor and its connection with the ground shall be tested for abnormal increase in resistance.

All stationary machines and equipment shall be tested every 6 mo, or more frequently if found necessary, for open grounding connections or increase in grounding resistance or to detect the presence of grounds.

All mobile and portable equipment shall be tested every 3 mo, or more frequently if found necessary, for open grounding connections or increase in grounding resistance or to detect the presence of grounds.

FLEXIBILITY—The selection of adequately rated system components and proper circuit arrangement is essential to obtain flexibility. Flexibility, however, is not necessarily measured by extra capacity alone. It is provided by the system that is expandable in economical kilovolt-ampere blocks. Provisions for load growth and change, without undue costs, are the criterions for a flexible power system.

Design Procedure

IN DESIGNING A POWER SYSTEM, considerable judgment must be exercised, even after all the facts are determined. It is not always possible to express in numbers or determine by formulas all the components of a distribution system.

Design procedure includes, among other things, the following:

1. Make a plan of the area, indicating location of buildings, structures, mine entrances and boreholes and points where power will be required for various operations.

2. Determine the amount and nature ot the loads.

3. Select the primary and secondary voltages.

4. Locate the main transformer station, switchgear house and distribution lines.

5. Arrange circuit layout.

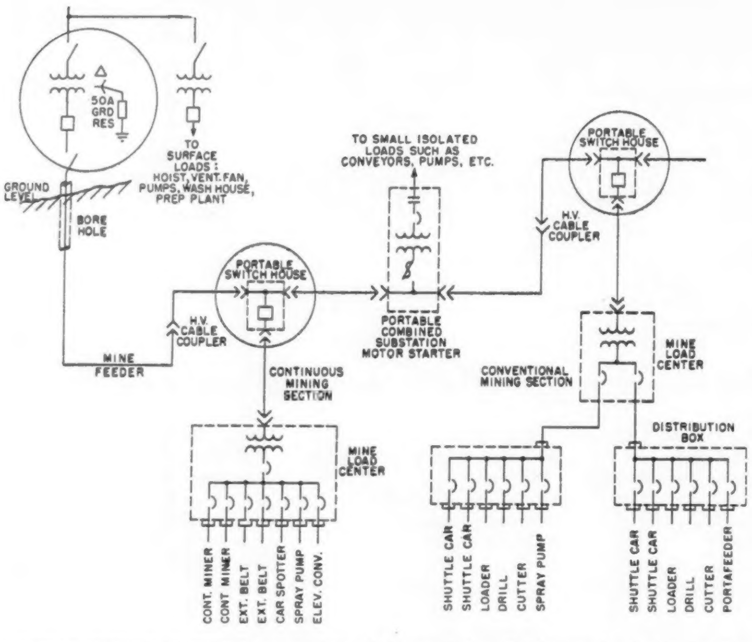
6. Provide circuit protection for the primary and secondary distribution systems.

7. Make provisions for power-factor correction.

8. Select lighting facilities for the preparation plant, offices, shops, change-house and the outside working area.

To get an overall picture of what is required in designing the power system it is essential to make a plan of the proposed system or the system to be revised. A one-line diagram will serve this purpose. This diagram should show the amount and nature of each load with respect to locations and load sites. It will help to develop the initial plan and give an idea of how the various electrical components will unite to meet system needs.

3.4 ELECTRIC-SYSTEM MAP—A map of



TYPICAL POWER SYSTEM for an AC mining operation. Equipment in circles are the surface substation, where voltage is reduced to distribution level, and underground switchhouses.

the mine showing the location of all circuits and stationary electric equipment comprising the electric system shall be kept. It shall show by suitable designation (1) size of conductors, (2) location of circuits and equipment and (3) capacity in horsepower, kilovolt-amperes and voltage appropriate for each motor, generator, rectifier, and transformer. The nature of the duty of each piece of electric equipment shall be indicated.

From the basic diagram, the power company's substation and the coal company's switchgear house can be located. Normally, the power company owns the substation that reduces the incoming voltage to a level selected by the coal company. From this point the coal company takes over. And it is at this point where the coal company must begin designing its distribution system.

Voltage Selection

A coal company's distribution system starts with a main substation or switchgear house where power is purchased. The main substation may reduce the voltage to the final levels of 220 or 440, or it may drop it only to 7,200 to 4,160 or 2,400 for transmission to load centers for final reduction. The number of voltage steps and the choice of voltages depends upon system load, transmission distance, safety and limitations imposed by mine laws.

The selection of voltage levels is probably the most important single factor in the design of a power system. Closely associated to voltage level are the limits on the amount of power that can be economically distributed from one point. Once these two decisions have been made they are difficult and costly to change.

2.1.20 HIGH VOLTAGE (HIGH POTENTIAL)—High voltage is voltage above 650.

PRIMARY VOLTAGE—Utilization voltage distribution—in the 440-V level—is limited to approximately 1,500 ft. Consequently, high-voltage distribution must be simple and flexible to accommodate frequent moving of underground load centers. Most new mines are selecting 7,200 V as the primary distribution voltage. Only recently has a 7,500-V cable connector been developed for use with the 7,200-V system.

The cost of equipment rated at 7,200 V is only slightly more than for 4,160 or 2,400 V, and the cable cost is considerably cheaper. The lower price for cable results from the fact that the higher voltage permits the use of smaller conductors to supply the same load at the same distance. A 7,200-V system can supply the same load at three times the distance of a 4,160-V system using the same-size cable. A 2,400-V system is capable of supplying only one-third that of a 4,160-V system. The cost of equipment for a 13,000-V system is three times that for a 7,200-V system. This will probably limit the use of 13,000 V.

Higher primary voltage, in most cases, means lower cost, greater flexibility and greater margin for expansion. More advantages can be gained with the 7,200-V system.

A 4,160-system costs less than 2,400. This is explained by the fact that switchgear for a given interrupting capacity costs less than 2,400-V equipment. Also, with a 4,160-V system a 1,200-amp circuit breaker, for example, will often carry full load current, whereas in a 2,400-V system the more expensive 2,000-amp breaker would be required. More kva can be carried in 4,160-V lines, resulting in fewer lines for a given power load. Cable costs are less for 4,160 because less copper is required.

The largest metal-enclosed circuit breakers made for 2,400 V are 150 mva maximum interrupting rating. For 4,160 the maximum is 250 mva. This allows for a much larger system to be built using 4,160 V without resorting to current limiting reactors or other expensive means of reducing fault currents.

UTILIZATION VOLTAGE—The advantages of higher voltages for secondary distribution are even more apparent. Theory indicates that the utilization voltage should be as high as possible, up to 650 V—voltages above 650 are classified as high voltage. In practice, however, 440 and 480 V are almost universally chosen because of the availability of standard 440- and 480-V utilization equipment.

Economically speaking, there is seldom any reason for selecting 220 V instead of 440 or 480, except where mine laws prohibit higher voltages. A 220-V system costs approximately 35% more than 440-V system because there is more current per kva to be carried; thus, larger circuit breakers and feeder conductors are required.

Surface Distribution

ALTHOUGH MAIN SUBSTATIONS usually are owned by the power company, various switching and protective devices normally are coal-company property. The point of purchased power may involve only switching and protective devices or it may include transformers and associated equipment.

The selection and arrangement of this equipment determines how well the complete system performs under normal and abnormal conditions.

6.1 BUILDINGS, TYPE—Substation buildings shall be of fireproof construction, well ventilated and equipped with a door or a gate that will permit the building to be locked to prevent unauthorized entrance.

Transformers

The primary function of a transformer is to change electrical power from one voltage level to another. This makes it possible to transmit, distribute and utilize AC power at the most economical and effecrive voltages.

Transformers are the very heart of the surface substation. Associated equipment serves to protect, control and monitor the overall power system. Transformers contain primary and secondary windings. The primary receives current at the input voltage and the secondary sends it out at the output voltage. The ratio of primary to secondary voltage is the same as the ratio of turns in the primary and secondary windings.

Practically all transformers are single-phase or combined three-phase units, the latter combining all phases in a single case or tank. The selection is usually a matter of preference but the three-phase units are gaining in popularity.

6.2.1 TRANSFORMERS FILLED WITH FLAMMABLE OIL—If the substation building contains transformers filled with flammable oil, the floor and floor drains shall

be so arranged that oil will quickly collect in a suitable drainage or storage system provided for the purpose either inside or outside the building as may be advisable.

6.2.2 TRANSFORMERS RATED ABOVE 25 KVA—If the transformers within the building are rated above 25 kva and are filled with nonflammable liquid, the transformer cases shall be equipped with pressure-relief vents connected to a chimney or flue that will carry gases generated by arcing within the cases to the outside of the building.

6.2.3 DRY-TYPE TRANSFORMERS—For new installations indoors, transformers rated above 25 kva shall be dry-type or nonflammable liquid-filled.

The extent of transformation depends on the size of the system (load demand), distance voltage is to be transmitted and voltage limits imposed upon the system by mine laws. Since the voltages of transformers are fixed the rating of an individual unit is determined by the amount of current flowing through it. Care must be exercised in selecting the correct rating to insure efficiency and adequate power for the system.

The voltage, winding connections, impedance and capacity are the main factors to be considered in selecting transformers.

The secondary voltage of transformers usually is determined by state mine laws. If the maximum voltage for distribution underground is limited, for example, to 4,160 V the transformer secondary voltage will be just that. However, there are a few exceptions where surface transmission distance is extremely long. In special cases it is desirable to go to higher voltage for surface distribution and reduce it to the permissible underground-distribution level at the mine entrance.

Voltage regulation is another factor which must be considered. Voltage drops in some cases can be as much as 5% to the underground power center. Correction for this drop can be made at the load-center transformer.

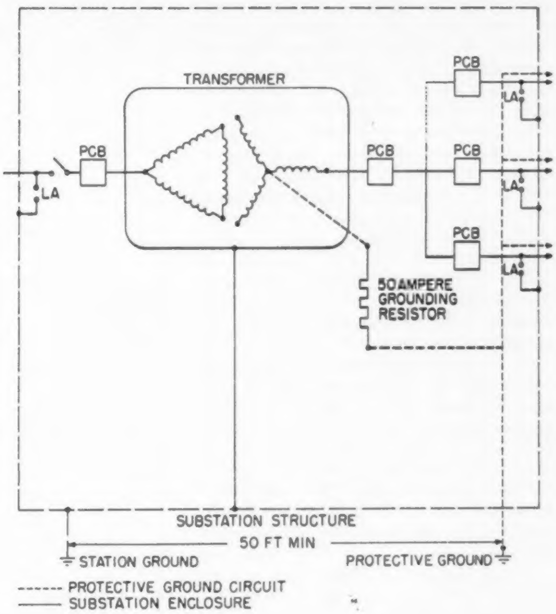
Cost of cable and equipment at different voltage levels varies considerably. From an economic standpoint, and since cable costs represent, in some cases, as much as 60% of the initial costs, comparisons must be made to justify the selection of certain voltages. Costs per kilovolt-ampere per 1,000 ft at different voltage levels are as follows:

Voltage	Cost per kva per 1,000 ft (Dollars)
2,400	5.25
4,160	3.00
7,200	2.00
13,000	1.20

Transformer capacity should be such that additional loads can be added to the system without increasing transformer capacity. Kva loads carried by surface transformers often reach 75% to 85% of the connected horsepower.

System Grounding

The most used and best way of grounding distribution systems is the neutral ground method. It provides better protection and is simpler.



NEUTRAL GROUNDING SYSTEM for surface substation.

2.1.10 EFFECTIVE GROUNDING—Effective grounding means that the path to ground from circuits, equipment or conductor enclosures shall be permanent and continuous and shall have carrying capacity ample to conduct safely any currents liable to be imposed on it. The path shall have impedance low enough to limit the potential above ground and to facilitate the operation of the overcurrent devices in the circuit. Where bonded or mechanically connected track is available, such track shall be considered the grounding medium.

Neutral grounding connections can be obtained in two ways:

1. Connect transformers delta-Y.

2. Use zigzag grounding transformers when delta-delta connections are used.

The chief advantages of the delta-Y connection are that it provides a neutral connecting point for grounding purposes, and is the simplest and best way of stabilizing the Y secondary neutral. This method does not require extra equipment to establish a neutral.

If the system is connected delta-delta there is no neutral connection point available. However, a neutral can be established by installing an external grounding transformer. It consists of a three-phase winding with no secondary. Each phase of this transformer is connected to a different line of the system. The grounding transformer neutral is then the same as the Y-connected system.

When a neutral has been established for the system, there also must be a method of grounding the neutral. The most desirable practices in mining are: (1) resistance grounding and (2) solid grounding. Resistance grounding is more widely used.

In resistance grounding the neutral is connected to ground through one or more resistances regardless of whether the secondary is connected delta-Y or delta-delta with a grounding transformer. The main reason for using resistors in the grounded-neutral system is to limit the amount of current during faults. The advantages are:

1. Minimizing electric shock hazards to personnel.

2. Reducing burning effects in faulted electric equipment.

3. Reducing mechanical stresses in circuits and equipment.

Solidly grounded neutrals are connected directly to ground without any provisions for limiting current. The disadvantage of this method is that personnel are exposed to large ground currents when faults occur.

The ohmic value of the resistor should be high enough to limit ground-fault current to a low value, yet small enough to permit sufficient ground-fault current to be selectively relayed by the circuit breaker relay. A 25-amp resistor will meet these requirements.

14.10 FAULT DETECTORS FOR HIGH-VOLTAGE CIRCUITS UNDERGROUND—High-voltage circuits shall be provided with devices for detecting faults to ground. Preferably, such devices should be capable of removing power from the circuits instantly in the event of a ground fault.

Main Circuit Breaker

Factors to consider in selecting circuit breakers are voltage rating, continuous current-carrying capacity, interrupting capacity and momentary-current capacity. Oil or air circuit breakers can be used.

Disconnect switches are one of the protective devices used in electrical circuits. They are knifeblade-type switches which

provide a means of isolating transformers and associated equipment from the source of power. These switches, normally, are not installed in the line to interrupt load but are used as a visible means of isolating the equipment when repairs or construction work are being carried on. This type of switch provides a large air space between live wires and equipment, which prevents leakage of power to the equipment. They also permit workmen to visually check that the system is disconnected from the power source. These switches are usually mounted on overhead pole lines and are opened and closed manually by insulated pole hooks that engage holes in each blade. They are normally mounted ahead of the oil or air circuit breaker.

On high-voltage systems the oil-type circuit breaker is used to guard against overloads or short circuits, and also to permit sectionalizing the system to isolate trouble. It should be noted, however, that air circuit breakers are being used more and more on high-voltage systems. The amount of protection that an oil or air circuit breaker provides depends primarily on the relays associated with it.

Circuit breakers are designed for momentary and interrupting ratings, and with automatic interrupting features. Momentary rating is the amount of current that a breaker will withstand, including short circuits from all sources. The breaker should safely open on any current within its rating.

The interrupting rating is the ability of a breaker to interrupt a fault current between the maximum and minimum designed voltage rating of the breaker. The rating is measured in megavolt-amperes.

Interrupting fault currents automatically is achieved by built-in tripping devices or by relays connected to the breaker. There is a wide variety of relays to choose from and the selection depends on the amount of protection required.

Facilities at the main substation normally consist of a master oil circuit breaker (one that provides protection for the overall system) and several branch circuit breakers that feed various loads. The master breaker provides additional back-up protection in case a branch circuit breaker fails to operate when a fault occurs in any one branch. The purpose of branch circuit breakers is to isolate trouble in a particular branch without interrupting service to the other branches.

Relays

Relays detect trouble in a distribution system. They are used in conjunction with circuit breakers to control the operation of breakers when faults occur.

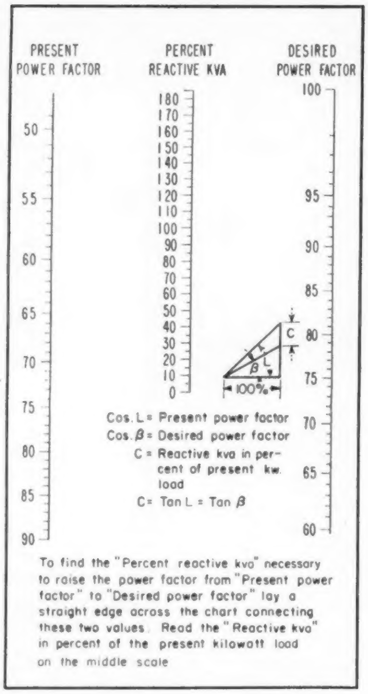
Relays are connected into the system through current or potential transformers, often called instrument transformers. Their purpose is to insulate the relays from line voltage and to reduce line current and voltage to values that can be applied to the sensitive mechanisms that are common in relay design.

These devices are classified with respect to the rate of speed at which they operate. Basically, these classifications are: (1) instantaneous, (2) high-speed, (3) time delay and (4) combinations of the three.

Instantaneous relays, as their name implies, operate within a few cycles after faults are detected. High-speed relays differ from instantaneous in that they operate within three cycles or less.

Time-delay relays are those that do not operate until a predetermined time has elapsed. The time ratings are usually adjustable but there are a few that have the time rating built into them.

Distribution systems can be protected from almost any fault condition that might develop within a system by proper selection and coordination of relays. The various relays are named with reference to the protection they provide. Those most often used are: (1), differential, (2) overcurrent or under-current and over-current directional, (3) over-voltage or undervoltage, (4) phase balance and (5) reclosure. All are available in various time ratings. For a more detailed discussion of the various types of relays most commonly used, see *Coal Age*, May, 1958 p 78.



BEST METHOD OF CORRECTING POWER FACTOR in a given case can be determined by a careful study of surrounding conditions. Without taking into consideration special features, the amount of corrective KVA may be determined by the use of the above nomograph copyrighted by Westinghouse Electric Corp.

Lightning Arresters

Protection against overvoltage caused by lightning is accomplished by installing lightning arresters in the system. How much protection against lightning a system should have depends on the location of the system and whether or not the location is subject to frequent lightning strokes. Installation costs vs equipment value and lost time due to interruptions must also be considered.

4.5 LIGHTNING PROTECTION—High-potential power lines and the equipment fed by them shall be protected against lightning and voltage surges.

Lightning strokes result in an overvoltage in the conductors. Arresters limit the accompanying surge by providing a path for it to travel between line and ground without permitting normal current flow. After a surge of lightning has been directed to ground, the arrester must prevent normal current in the system from also flowing to ground. Summing up, arresters perform two operations: (1) direct the surge to ground and (2) stop the current in the system from also flowing to ground after the surge has passed.

Several types of arresters are available for various applications:

1. Distribution-type.
2. Line-type.
3. Station-type.

Distribution-type arresters are used to protect transformers, cables, capacitors, meters and circuit breakers. They are designed to permit mounting on poles and crossarms. They are relatively inexpensive and are easy to install.

Line-type arresters are similar to the distribution type but are more suited for protecting small equipment.

Station-type arresters provide better protection than the other two. They are used, as the name implies, to protect stations and other equipment of extreme importance.

Lightning arresters, as well as all substation equipment frames, should be connected to the main substation ground grid.

Power-Factor Correction

There are few AC systems that do not require power-factor correction. Correction can be made either at the substation for system correction, at the load for individual correction, or both. This latter is not an uncommon practice. As a matter of fact, power-factor correction is being treated with as much importance today as any other phase of the power system. Once the money-saving potentials of power-factor correction are recognized, it will be applied to more systems. The saving is not in power bills alone but also in the reduction of load on the system which permits equipment to operate on a more normal power supply, thus reducing repair bills on the equipment.

The device most often used in mining systems to correct power factor is the capacitor. This, however, is not the only means. Other correction includes the use of synchronous motors, and the proper application of induction motors.

Capacitors can correct and bring power factor up to 90 to 95%, which normally takes the mine out of the penalty area and reduces the reactive power in the system. Some systems may require overall correction and also correction at the centers of groups of induction motors. Still other systems would require correction at only one of the two locations.

Correction at the main substation consists of installing a capacitor bank with sufficient ckvar (capacitor kilovolt-amperes-reactive) to bring the power factor to the desired rating. The ckvar value is determined by the

amount of kw and kvar of the system. From these values the kva and power factor can be calculated.

Overhead Pole Lines

MOST DISTRIBUTION SYSTEMS include overhead pole lines even though, in some instances, they are short. The two-step voltage arrangement normally requires more overhead construction than the one-step system. Transmission of high voltage from main substation to intermediate substations often involve several miles of overhead power lines.

The spacing of conductors determines, in part, the amount of reactance in transmission lines which, in effect, causes voltage drop and poor power factor. Lines spaced far apart produce more adverse effects on each other than lines spaced closer together but this has its limits in overhead-pole-line construction.

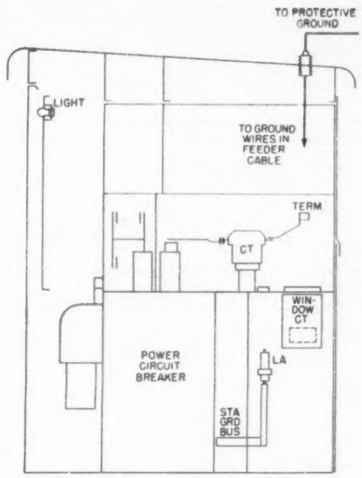
The size and type of conductors with respect to radius and surface conditions help reduce line reactance. For the average mine setup, these two factors have very little effect on the amount of reactance in the system. Conductors are usually selected in accordance with the transmission distance and voltage level.

A ground wire normally accompanies the power conductors. Lightning arresters should be installed at intervals of approximately 1,500 to 2,000 ft. The ground wire is connected to the ground side of the arresters. This method has proved most satisfactory and is widely used in surface distribution systems. Code provisions for surface power lines are as follows:

4.1.1 CIRCUITS CARRYING 15,000 V OR LESS—Overhead high-potential power lines of 15,000 V or less on mine property shall be at least 20 ft above roads and driveways and at least 15 ft above the ground at points accessible to pedestrians. They shall be supported and guarded adequately to prevent contact with surface structures as well as with other circuits. The height of such power lines shall be not less than 28 ft above railroad tracks. When heavy equipment or loads on equipment must pass under power lines where clearance is questionable the power shall be removed from these circuits until the equipment has passed safely under them.

4.3 GROUNDING WIRES, PROTECTION—Grounding wires attached to the surface of a wooden pole shall be protected by a wooden casing and shall not make contact with cross-arm braces or other exposed metal parts.

4.4 GUY INSULATOR—An insulator shall be located in each guy attached to a pole or structure that carries supply conductors of more than 300 V to ground or in any guy exposed to such voltages. This guy insulator shall be at least 8 ft above the ground. However, a guy insulator is not required where the guy is effectively grounded such as by an electrical connection to grounded steel structures or to a ground connection on wooden poles.



SWITCHGEAR arrangement for typical underground circuit.

4.6 OVERCURRENT PROTECTION — High-potential power lines shall be protected against excessive overcurrent.

Portal Control Station

AT THIS POINT of the installation there are several standards for distributing AC power underground. These standards provide safety for men and equipment and contribute to an efficient underground distribution system.

The power should enter the mine as near the load center as possible for two reasons:

1. To reduce the amount of high-voltage cable underground.

2. To minimize voltage drop between the substation and load center.

In most cases the substation will be located near the place where power is taken underground. Consequently, it is not necessary to provide an extra switching station equipped with circuit breakers and necessary protective relays, such as, overcurrent and phase balance, as well as ground-fault detectors and lightning arresters. On the other hand, if the entrance is located some distance from the substation it would be necessary to provide a separate installation, including all the protective devices listed.

Ground Protection

Protection of underground high-voltage systems can be achieved in several ways but probably the best method is the pilot-wire system employing differential-type relays. A small amount of line current is permitted to flow in the pilot wires through the secondary of current transformers. These pilot wires are carried with the power conductors.

The amount of current at one end of the line is the same as at the other end. When the current in the pilot wire becomes unbalanced, due to faults in the line, the relay operates and opens a circuit breaker. This method provides phase-to-phase as well as ground-fault protection.

An additional feature of this protective system is a relay for continuously checking the condition of the pilot wires. If the wires become short- or open-circuited, the relay will operate, indicating that the system is no longer protected against faults. The lines can then be inspected and repaired.

4.7.1 LIGHTNING PROTECTION—Each exposed power circuit that leads underground shall be equipped with lightning arresters of approved type at the point where the circuit enters the mine. If the power circuits leading underground are 100 ft or more long on the surface, suitable lightning protection shall be provided at the generating station or substation and at the point where the circuit enters the mine.

4.7.2 SURFACE DISCONNECTING SWITCH—Each power circuit leading underground shall be provided with a switch in each conductor of the circuit for visibly disconnecting the circuit from the source. This switch shall be placed on the surface not more than 500 ft from the point of entrance to the mine.

4.7.3 OVERLOAD PROTECTION—All circuits leading underground from substations and transformer stations shall be provided at their source with current-interrupting devices of such capacities and so installed and adjusted that the circuit will be opened if the current in the circuit exceeds the safe carrying capacity of the conductors leaving the stations. Three-phase delta or Y-connected AC circuits shall be protected by a fuse or a circuit breaker in each ungrounded wire.

4.7.4 CABLES, TYPE—Cables in shafts boreholes and underground passageways leading from the surface shall be of a type approved for the service intended, installed in an approved manner and guarded against damage from external sources.

4.7.5 CABLE INSULATION AND SUPPORT IN SHAFTS—All power conductors in shafts shall be covered with approved insulating materials throughout or guarded in an approved manner. However, grounded conductors of grounded DC systems shall be supported on insulators but need not be covered with insulation. Conductors shall be securely fastened in such a way as to support them properly. They shall be supported out of contact with combustible materials. When the length, weight and construction of a shaft cable are such that suspension from its upper end only would subject the cable to possible damage, it shall be supported in an approved manner at such intervals as may be necessary to prevent undue strains in the sheath, insulation and conductors.

4.7.6 SHAFT CABLES, MECHANICAL PROTECTION—Shaft cables shall be so placed or protected that they will not be

subject to damage from moving cages and skips, ice, coal or other falling materials or to damage from mine water and electrolysis.

4.7.7 BOREHOLE CABLE INSTALLATION—All conductors passing underground through boreholes shall be installed in an approved manner to prevent undue strains in sheath, insulation or conductors, and damage by chafing of cables against each other or against the borehole casing.

Underground Distribution

IN CONJUNCTION WITH THE SURFACE SWITCHING ARRANGEMENT, high-voltage cables entering the mine through boreholes or shafts are equipped with circuit breakers at the bottoms of these openings to interrupt power feeding into the mine in case of emergency and also for repairs.

5.5 DISCONNECTING SWITCHES—Disconnecting switches shall be installed in all main power circuits near the bottom of shafts, boreholes and other places where these power circuits enter the mine. High-voltage disconnecting switches shall be accesible only to properly qualified persons and shall be arranged so they can be locked in the open position, or a danger sign must be placed on the switch by the person who opens it. Disconnecting switches also shall be provided near the beginning of all high-voltage branch circuits. They shall be located preferably in well-ventilated fireproof rooms.

Cables

Insulated multiple-conductor cables equipped with ground wires and a conducting shield over both ground and power conductor are used to transmit high voltage underground. Type SH-D cables with adequate kilovolt rating are used in most installations. The length of these cables normally is kept to a maximum of 1,000 ft. They are connected by high-voltage couplers or potheads.

5.1 LOCATION—All underground power circuits other than portable cables shall be installed in a permanent manner and so located as to minimize possibility of damage by (a) mine water, (b) falls of rock and coal or (c) movement of strata. Protection from damage by wrecked trips and blasts should also be considered.

It is recommended that power circuits shall be installed only in regularly inspected intake airways. AC power circuits installed in the vicinity of trolley wires shall be covered or placed so as to minimize the possibility of being struck by current collectors, such as trolley shoes or wheels, or by other haulage equipment.

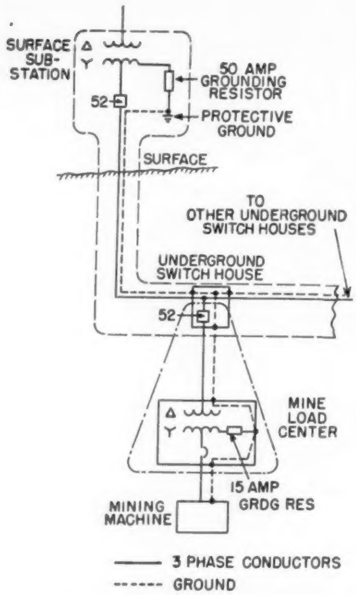


DIAGRAM shows protection provided by primary switching devices.

5.2 CABLES, HIGH-VOLTAGE—In selecting the type of cable, including the mechanical and electrical characteristics of the insulation and outer covering, such factors as electric shock and fire hazards, deterioration from mine water and electrolysis and means of suspending or other wise supporting the cable must be considered.

Cables for high-voltage circuits underground shall be either the metallic armored or nonmetallic sheathed type. Metallic armored cables may be supported (1) on messenger wires or (2) directly on hangers, both of which shall be suspended by means of insulators if supported on coal or other combustible materials, or (3) they may be buried in accordance with Sec. 5.4 which follows.

Unshielded nonmetallic sheathed cables shall be installed in metallic conduit.

When conductors or cables are enclosed in metallic armor, conduit or shields the armor, conduit or shields shall be electrically continuous throughout and effectively and permanently grounded.

5.4 BURIED CABLES IN ENTRIES AND SLOPES—Power cables buried in the mine floor shall be not less than 12 in below combustible material. Where such cables pass under mine tracks they shall be not less than 36 in below the tracks, unless adequately protected against crushing from the weight of passing trips or heavy equipment.

Couplers

From a safety viewpoint it is better to use couplers equipped with padlocks, key interlocks, or fitted with pilot-wire connectors. Any one of these safety devices will permit only authorized personnel to disconneot the couplers and also eliminate the possibility of persons connecting them while repairs are being made.

Distribution Control Stations

AS TRANSMISSION DISTANCES INCREASE it is necessary to sectionalize the cables at intervals of approximately 2,000 ft. This means that a circuit breaker or other disconnecting device is installed in the line at these intervals. This also applies to branch circuits that feed other sections of the mine. In addition to the circuit breaker these branch circuits should include necessary protective equipment.

2.1.35 SECTIONALIZING SWITCH—A sectionalizing switch is a switch used for connecting or disconnecting (or both) adjacent electric circuits.

As in the surface substation, phase and ground overcurrent protection should be provided. These relays should be chosen to coordinate with backup relays. The ground relay should be selected to operate from a balanced-flux current transformer and to pick up ground-fault currents in the neighborhood of 5 amp. The ground-fault relay in the control station nearest the load should be an instantaneous relay.

Cable monitoring equipment is often used in the control station to monitor ground wire continuity from the control station to the mine power center.

Mine Power Center

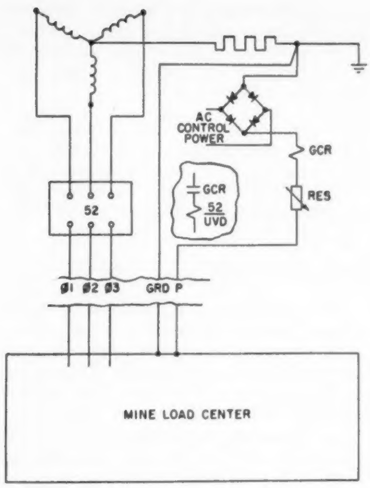
THE HIGH-VOLTAGE CABLE from the control station is terminated at the load-center with the same type of coupler used in the intermediate sections, with one-half of the coupler permanently mounted on the load-center frame. The power conductors are connected to the transformer and the ground wires are grounded to the frame.

The purpose of the load center is to reduce the high voltage to actual utilization voltage and to provide switching and fault protection for branch circuits. It is a combination power and distribution center. However, individual units may be installed for the same purpose, although the combined unit seems to be preferred.

Transformers

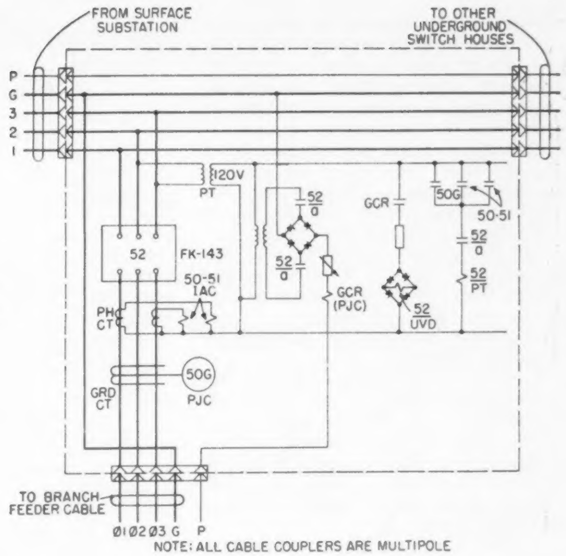
Dry air-cooled or inert gas-filled transformers can be used underground. The former are more widely used because, among other things, the liquid-filled units must have a separate split of air.

The dry-type transformer should have a 5% low tap to compensate for a 5% system voltage drop. The secondary (utilization) voltage usually is 480 V when permitted by state laws. Where state laws limit utilization voltage to 220, voltage regulation and cable size become such difficult problems that the use of AC is discouraged. The 480-V three-phase system with neutral resistor ground provides a phase-to-ground voltage of 277 V.



GROUND CONTINUITY check relay scheme for mine power center.

ELEMENTARY diagram for underground switchhouse.



The load-center transformer winding must contain a delta winding. If only a single-voltage primary is required, the primary winding should be delta to permit a secondary neutral connection. If a delta-wye dual-voltage primary winding is necessary the secondary winding must be delta-connected. In this case a zig-zag grounding transformer must be used to establish a secondary neutral point.

The capacity of mine-power centers usually is based on approximately 1 kva per connected horsepower. Standard capacity of power centers for conventional-mining equipment is 225 kva, and for continuous-mining equipment, 300 kva. Units as high as 600 kva are being used to provide power for as many as three sections. However, this setup produces serious voltage-regulation problems because portable cables are too long.

Circuit Breakers

Back-up protection is provided for each branch or bus circuit by installing a breaker between the transformer and bus. This gives added protection when relays are properly coordinated. It is, however, possible for both breakers to trip at the same time, which would cause a delay in the other branch circuits. But, in most instances, when a fault occurs in any one branch it will trip only the branch circuit breaker and not disturb the others.

Air circuit breakers are mounted on the low-voltage panelboard to protect the low voltage cables. Each breaker feeds to a low-voltage receptacle, which supplies power to individual face equipment.

Circuit breakers are of the molded-case type which have integral, thermal and magnetic trips for phase protection. An undervoltage trip coil is included in each breaker to provide a positive method of tripping the breaker under no-voltage or undervoltage values. Ground faults are detected by the balanced-flux current-transformer method. Sensitive relays open the undervoltage trip circuit on ground faults of 3 to 7½ amp.

Utilization Distribution

THE ELEMENTS OF CONCERN at this point in the distribution system are cables, couplers and ground continuity. Once cables and couplers are selected and installed, the only everyday task remaining is checking ground continuity. This is vital if safety for men and equipment is to be maintained.

13.3 CABLES FOR PORTABLE AND MOBILE EQUIPMENT—Cables used for connecting portable and mobile equipment to a source of energy shall be flexible, adequately insulated and of approved flame-resistant type. Such cables shall have ample current-carrying capacity to prevent damage by overheating and shall have short-circuit protection at the point of connection to the power circuit.

Cables shall have an approved trolley tap with insulating handle or an equivalent device for making connections safely to the power circuit.

13.4 PORTABLE CABLES. INSPECTION AND MAINTENANCE—The operators of portable equipment shall examine cables daily for abrasion and other defects. If a cable breaks down in service or causes a person to receive a shock, it shall be put out of service at once and shall not be used until it has been repaired. Permanent splices in portable cables shall be electrically and mechanically efficient and shall be waterproof. Portable cables having five temporary splices shall be replaced by new cables or by cables in which permanent splices have been made before the next shift begins.

Cables usually are sectionalized in 50- and 100-ft lengths so that their bulk will not be excessive. Keeping cables short helps reduce voltage drop.

Couplers attached to the ends of the cable sections should be designed to prevent injury to persons connecting and disconnecting them.

Ground-continuity checking devices are difficult to maintain in portable cables, especially those that are spooled on reels. Special efforts should be made to maintain continuity.

DC Power Systems

CONVERSION EQUIPMENT INCLUDES the old-reliable converters and m-g sets, but the standard unit today is the mercury-arc rectifier, including the glass-bulb type. A few metallic rectifiers of the selenium type are in service and units based on germanium, silicon and other metals are now available.

Conversion Capacity

Higher horsepower per machine and per section is requiring an increase in the capacity of rectifiers and other conversion equipment. A recent series of tests on power required by continuous miners indicates that the capacity for a single section (miner and shuttle cars, roof drill, etc.) should be at least 200 kw.

Dull bits on miners and other equipment have a major effect on power demand and consumption. It one test with dull bits, miner advance was 20 ft, demand was 82.4 kw and consumption was 32.47 kwhr. Time was 50 min. With sharp bits, advance in 54 min was 30 ft. Demand was 69 kw and consumption was 31:33 kwhr (J. O. Cree, 1956 Coal Convention, American Mining Congress).

AUTOMATIC OPERATION—The high cost of labor naturally dictates making substations automatic. Equipment now is available for positive, automatic and continuous monitoring and control of outlying substations and fans by a central circuit-scanning system (*Coal Age*, October, 1959, p 102). Basically the system is an electrical one, using plug-in relays which are easy to install. The scanning system requires two wires which contact every station to be controlled.

PORTABILITY—For the maximum in

convenience and efficiency, the trend is toward portable conversion units. Such units also may be placed in permanent locations—to serve main-line haulage, for example. Or stationary types may be employed at some saving on cost.

Portability facilitates keeping transmission distances short. However, if the cover is shallow, some mines have felt that the lower cost of pole lines and surface facilities, even when offset by the cost of boreholes, warrented keeping conversion equipment on the surface, even with 275 V as the nominal voltage. With 550 V, the reduction in number of moves otherwise necessary is an added reason for considering keeping conversion equipment outside.

Heavy locomotives bring up the problem not only of placement and capacity of substations but also the effect on the remainder of the system as the locomotive passes a given point. To reduce disturbance in face operation as a result of locomotive operation, substations may be equipped with automatic load distributors.

Transmission Limits

The maximum distance DC can be transmitted from the substation depends on a number of factors, and must be calculated for each individual operation. Balancing everything, the distance should not exceed 3,000 to 3,250 ft for an 800-amp average transmission, 300 V at the nips and 250 V at the machine.

Even with the maximum in feeder capacity it is difficult to maintain adequate voltage, let alone rated, for 250-V motors at distances much over 4,000 ft. Incidentally in increasing feeder capacity, it is better to use a number of smaller cables than one large one because the current-carrying capacity is greater. At 30C ambient temperature, 45-deg rise, for example, approximate ratings are: 500,000 cir mils, 800 amp; 1,000,000 cir mils, 1,230 amp; 1,500,000 cir mils, 1,550 amp.

ALUMINUM FEEDER — A decidedly lower relative cost makes aluminum very advantageous for bare feeders alongside trolley wires or elsewhere. It has greater bulk, however, and consequently the advantages are largely offset by the increased insulation and jacket when used for high-voltage power cables or low-voltage trailing cables. But with bare feeder, aluminum has about 70% the current-carrying capacity of copper, and 3 ft of aluminum feeder can be bought for the price of 1 ft of copper.

Sectionalization

Safety, quick isolation of fault areas, and quick replacement of damaged facilities are among the benefits of sectionalization. The latter applies particularly to the growing custom of using short lengths of cable with push-pull connectors in distribution of power at the face. Connector design is such that power is removed before the circuit is opened.

Recommended sectionalizing practice may be summarized as follows:

1. Provide in every instance sufficient capacity in the feeder and return so that the most remote dead short will open the overcurrent protective device, usually an automatic reclosing circuit breaker.

2. Install an overcurrent protective device in the circuit between each two substations at a point where resistance both ways is equal. If enough copper is used so that a ground at any point will open the protective devices at both substations, no intermedi te protection is necessary. A section insulator, or "dead block," may be used between substations if they need not be paralleled.

3. Insert a disconnecting switch or protective device at intervals of not over 1,500 ft in all power lines.

4. Install an overcurrent-protective device in each circuit leaving a substation—fuses, or manual or automatic-reclosing circuit breakers. Circuit breakers should have trip-free operating mechanisms. The exception is where a substation feeds only one haulage unit, in which case only one station breaker is required.

5. Place an overcurrent protective device at each branch circuit.

6. Protect each circuit feeding a local section or territory with an overcurrent device.

7. Install overcurrent protection at the supply end of each circuit to pumps or other fixed loads.

8. Install switches to cut power off unimportant and infrequently used branch or stub circuits.

9. Protect each mining setup with an overcurrent device.

10. Keep overcurrent circuit-breaker settings or fuse ratings as low as practical for good operation. Specific settings are listed in a discussion of the subject in *Coal Age*, December, 1958, p 96.

11. Cut power off all idle territories during non-operating times. If it is necessary to run a pump or some other one unit, special overload protection no greater than needed should be provided.

Unit Resistance of Common Sizes of Copper Wire and Steel Rail

COPPER WIRE

Size, CM	Resistance, Ohms per 1,000 Ft
1,500,000	0.00719
1,200,000	0.00899
1,000,000	0.0108
750,000	0.0144
500,000	0.0216
300,000	0.0360
211,000	0.0509

STEEL RAIL

Weight	Equivalent Each Rail, CM of Copper	Resistance, Ohms per 1,000 Ft (both rails bonded and cross-bonded)
30	300,000	0.0180
40	400,000	0.0135
50	500,000	0.0108
60	600,000	0.0090
70	700,000	0.0077
80	800,000	0.0067
90	900,000	0.0060
100	1,000,000	0.0054

Ground Protection

The solid wire from machine frame to ground provides protection to men from short circuits—under most conditions—but no protection to the machine. Thus, some other provision is necessary. The original unit, still widely used, was the fuse, either in the junction or distribution box or in the trailing-cable nip. A major disadvantage is that a ground fault of low intensity, say 100 amp, is not sufficient to blow a fuse—or operate a circuit breaker—rated or set at 200 amp.

The best answer to this latter condition is a three-pole circuit breaker, with one pole in the grounding circuit equipped with a 5- or 10-amp current-limiting relay. A low-intensity fault will trip the breaker as a signal for corrective measures, while a high intensity fault will be cut off before severe equipment damage occurs.

A new protective device for personnel and machines without the use of a frame-ground wire has been developed. The device

1. Permits the use of two-conductor cable in a completely safe and approved manner.

2. Provides positive protection for ground faults occurring anywhere on the machine.

3. Provides positive protection for short circuits occurring anywhere on the machine or its trailing cable.

4. Acts to remove power in the event of a broken or open cable conductor.

5. Distinguishes between short circuits and normal operating overloads.

6. Prevents energizing equipment when a dangerous condition exists.

7. Eliminates possible severe arcing that can occur with a ground fault when a grounding conductor is employed.

8. Is essentially "fail-safe."

The device always removes power from the machine *and* its trailing cable. It is designed for use on mobile mining machines to provide complete protection against the electrical faults expected in operation of the machine and cable. This is accomplished without a grounding conductor in the trailing cable. At present, only 250- and 500-V DC models are available.

The complete unit includes a small electronic oscillator unit mounted on the machine, a pushbutton station, also on the machine, and a receiver unit in a safety circuit center at the outby end of the trailing cable. The safety circuit center also includes the customary circuit breaker of adequate capacity for the machine and is equipped with plugs and receptacles for easy cable attachment.

Maintenance for Minimum Cost

Since 1955

Preventive maintenance assumed greater importance as a result of increased use of more complicated and costlier equipment, and as a means of lowering operation cost.

Maintenance budgets increased.

Shortage of maintenance personnel overcome through better selection and training.

Ahead to 1965

Maintenance engineering will be the influencing force working for better and more maintenance at lower cost.

Industrial engineering to play major role in maintenance organizations to improve standards and techniques.

Automatic office machines and computers will take over much of the recording and reporting work load.

More money will be spent to provide higher education in the electrical, hydraulic and mechanical fields to deal with the more complicated machines now entering the picture.

MAINTENANCE ORGANIZATIONS, old and new, will undergo numerous changes in the years ahead. Why? The answer is twofold:

1. Machines continue to take over more of the production load and more production capacity is being concentrated in individual machines.

2. The cost, capacity and complexity of modern equipment increases the burden on maintenance departments.

Future equipment designs—those still in the drawing-board stage—provide for controlling the new machines by methods which to date are unfamiliar to the mining industry. Add to these the rising cost of labor and materials for both operation and maintenance, and a well organized maintenance department with qualified supervisors, engineers and technicians becomes a must.

Future maintenance organizations will require "maintenance engineering" to cope with added responsibilities and new techniques. Automation and electronics will assume major importance in the mining industry in the not-too-distant future. These new fields of technology give insight into the future of maintenance and highlight the need for more engineering ability. Electricity, hydraulics and mechanics will require more engineering know-how tomorrow. Consequently, maintenance departments must organize and staff accordingly. Otherwise, production goals will never be reached nor will it be possible to control operating cost.

The importance of maintenance must not only be realized. Follow-through is vital and the first step is to determine what the organization should be and what it should do.

Although the answers to these questions seem obvious, they are often lost sight of in actual practice. But once the cornerstone is in place the building of a maintenance organization can proceed simply and smoothly on a solid foundation. When complete it will provide all the "should bes" and "should dos" that are expected of it.

Maintenance organizations and practices differ within each company, reflecting company policy, type of equipment, size of company, whether the company is engaged in deep or strip mining or both, and the general concept and basic philosophy held by management.

Organization

ORGANIZATION is the establishment of authority, responsibility and relationships to achieve the end results. The necessity for applying and emphasizing these factors with regard to maintenance organizations has become more and more apparent with modern-day mining equipment.

Development

A maintenance organization and its program may seem complex when viewed as a whole but when reduced to its component parts it becomes simple and easy to understand. But why is maintenance so necessary? Here are a few reasons:

1. The influence of maintenance on production costs.
2. Effect of output with regard to operating versus breakdown time.
3. Protection and improvement of capital investments.

The establishment of an organization and the development of maintenance methods must have the support and understanding of top management if it is to be successful. To obtain this it is necessary to prove the value. Whether support is needed to set up a new organization or improve the services and facilities of an existing program, it is important to present your case or proposal to management showing improvements and justification for the action. The proposal should include, among other things the following:

1. Cost of maintenance in relation to production. This can be shown as a percentage of total cost or in dollars and cents.

2. Analysis of operating time losses due to lack of maintenance and a rundown of where improvements can be made.

3. Data on maintenance productivity in terms of maintenance cost relative to replacement value of repair parts or equipment, or other comparisons which illustrate the point.

Impress upon management that you know your problems and offer the necessary plans, including cost estimates, methods of approach, time tables for expected improvements, etc., for those areas of maintenance to be included in the proposal.

Getting the go-ahead from management to carry out the proposal makes it necessary to take steps to measure, control and improve maintenance methods, facilitate proper allocation of men and material and reduce the cost of maintenance services and facilities. These tools include, among others, the following:

1. Classified Accounts — Simplify paper work and aid in monitoring all areas of maintenance cost and delays.

2. Delay and Work-Needed Reports — Keep management (operating and maintenance) informed of the effectiveness of maintenance and of immediate and future maintenance requirements.

3. Perpetual Equipment Records—Provide data for spotting weak machine components, indicate areas of high maintenance costs and enable maintenance management to determine when machines should be overhauled and when machine components should be changed or redesigned to improve performance and safety.

4. Program Plan and Work Schedule — Enables management to develop an orderly program for scheduling all maintenance work and assigning men so that it can be performed at designated intervals and completed within established time limits.

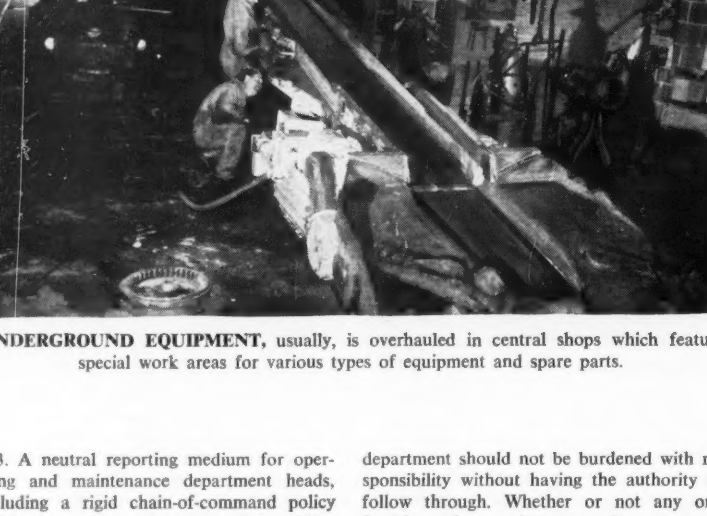
5. Maintenance Standards—Give management the necessary tools to evaluate work performance, job costs and methods of work procedure.

During development of the maintenance organization specific requirements in the administration of the program should be given priority. These consist of:

1. An organization capable of performing all maintenance functions effectively.

2. An organization chart listing the responsibilities and authority of each maintenance supervisor.

SERVICE UNITS for strip mine equipment consist of mobile units, such as, welding trucks, lubrication trucks, etc. Units make routine and emergency stops.



UNDERGROUND EQUIPMENT, usually, is overhauled in central shops which feature special work areas for various types of equipment and spare parts.

3. A neutral reporting medium for operating and maintenance department heads, including a rigid chain-of-command policy within the maintenance department and between it and the operating department.
4. A preventive maintenance program.
5. An effective cost-control program.
6. A complete report and record system.
7. A good supply system.

Responsibility

There is no single set of rules that can be applied in organizing maintenance systems. However, certain basic principles are necessary. Systems must be custom-designed to meet the needs of the individual company. As a result each maintenance organization reflects company policy, types of equipment, size of company, whether the company is engaged in deep or strip mining or both, and the general concept and basic philosophy of management. A good maintenance organization also will display the best in management practices, engineering judgment and common sense, plus proper distribution of responsibilities and authority.

Responsibility and authority, in a sense, are one and the same. Certainly a person or department should not be burdened with responsibility without having the authority to follow through. Whether or not any one function of a maintenance department is more important than another is secondary. What is important is that each function for which the maintenance department is responsible should be carried out in a businesslike manner and the cost kept within the budget, regardless of its priority.

The functions for which the maintenance department will be responsible should be established in the initial planning and organizing stage or, in existing organizations, the functions should be re-evaluated.

The "major functions" listed at the beginning of this article provide a basis for developing a maintenance organization. The list can be altered to meet the needs of the individual companies.

Authority

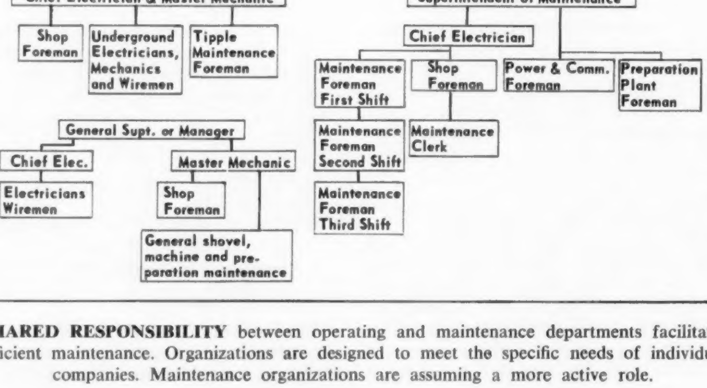
Once the responsibilities have been established, delegating authority logically follows as the next step in organizing. Authority, which goes hand-in-hand with responsibility, should be based on analysis of the job to be done. It also should be defined and contain little or no overlap if confusion and buck-passing are to be avoided.

The desirable chain-of-command policy today is to provide a common or neutral reporting medium for production and maintenance department heads. The general manager or an executive of equal status, for example, has proved the more appropriate.

In the upper echelon of the organization the maintenance superintendent, assistant maintenance superintendent, chief electrician, equipment inspector and special engineers or supervisors have their specific place in the organizational setup, each position with its necessary degree of authority.

It also is necessary to establish lines of authority between first-, second- and third-shift maintenance foremen. There are two avenues of approach: (1) give the first-shift foreman control over the second- and third-shift, or (2) delegate equal authority to each shift foreman, thus placing them on the same level in the organization.

Title assignment is one area of maintenance structure where management needs applied common sense. Each supervisor should be given an appropriate title—one that matches his responsibilities and authority and one that "flavors" his position with respect and prestige.



SHARED RESPONSIBILITY between operating and maintenance departments facilitates efficient maintenance. Organizations are designed to meet the specific needs of individual companies. Maintenance organizations are assuming a more active role.

FOREMAN'S SIGNATURE	APPROVED	PRODUCTION AND DELAY REPORT	MINE	SECTION	DAY	NIGHT	DATE		

SHIFT PRODUCTION		HOURLY PROD.			WORK TIME		MATERIALS USED				HT.	WD.	DEPTH
CAR AVG.	NO.	CLOCK HOUR	MINE CARS	△ REF.		TIME	ITEM	NO.	ITEM	NO.			
TONS LOADED		7 / 3			LV. PORTAL		POWDER		Split Posts		NO. OF MEN		
MINE CARS LOADED		8 / 4			AR. SECTION		CAPS		Wedges		Work / Absent / Repl. / Extra		
PLACES LOADED		9 / 5			AR. FACE		Mech. Bits		Rock Dust		JOB OF ABSENTEES		
Pl. Cut, Drld, Shot		10 / 6			LV. FACE		Drill Bits		SALT				
PL. CUT & DRLD		11 / 7			LV. SECTION		Roof Bits		Round Posts				
PL. DRLD & SHOT		12 / 8			AR. PORTAL		Gal. Oil In		Crib Blocks				
PLACES CUT		1 / 9			Actual Face Time		Oil Cans Out		Roof Bolts				
PLACES SHOT		2 / 10			Standard Face Time						Any Injuries Reported No ☐ Yes ☐		
PLACES BOLTED		3 / 11			Gain or Loss Face Time								
PLACES SCRAPPED		PLACES LOADED			1	2	3	4	5	6	7	8	9

CONDITION OF SECTION							
PL.	SHOT	CUT & DRLD.	CUT	DRLD.	BLTD.	EQUIPMENT LOCATION	PHYSICAL CONDITION
1							
2							
3							
4							
5							
6							
7							

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

DELAY REF.	MACH. NO.	MACHINE	POSITION	DELAY ACCOUNT		CAUSE OF DELAY		MATERIAL USED			DELAY MIN.		REPAIR COST		
				CODE	UNIT ASSY. OR EVENT	CODE	ACCURATELY DESCRIBE CAUSE OF DELAY	QUAN.	CODE	PART NAME	TOTAL	LOADING	LABOR	MTL.	TOTAL
A															
B															

EQUIPMENT CHECKLIST

Foreman's Signature______ Date______ Sec. No.______ ☐ Day ☐ Night

No.	Loader No.___	√	O	No.	Cutter No.___	√	O	No.	S. C. No.___	√	√	SC___	√	O	SC___	√	O
1	Cats			18	Cutter Chain			35	Conveyor chain			52			69		
2	Cat drive chain			19	Cutter bar			36	Brakes			53			70		
3	Conveyor chain			20	Tires			37	Tires			54			71		
4	Swing rope			21	Lights			38	Lights			55			72		
5	Motors			22	Motors			39	Motors			56			73		
6	Hyd. system			23	Hyd. system			40	Hyd. system			57			74		
7	Hyd. pump			24	Hyd. pump			41	Hyd. pump			58			75		
8	Lubrication			25	Lubrication			42	Lubrication			59			76		
9	Hot			26	Hot			43	Hot			60			77		
10	Cable			27	Cable			44	Cable			61			78		
11	Nip or breaker			28	Nip or breaker			45	Nip or breaker			62			79		
12	Cat controls			29	Safety clevis			46	Reel			63			80		
13	Conv. swing			30	Cover plate			47	Wheel units			64			81		
14	Jacks			31	Drill			48				65			82		
15	Clutches			32	Clutches			49				66			83		
16				33				50				67			84		
17				34				51				68			85		

T-2 Truck & 135L:

T-2 Truck & Compressor:

Stoper:

Elevator:

Car Spotter:

STATE EXACT REASON FOR EVERY "O" ON CHECK LIST

PRODUCTION AND DELAY REPORTS, and equipment checklists, provide perpetual performance records for equipment. Reports above are filled out by section foremen.

Personnel

THERE IS NO PLACE in a maintenance organization for men who are not electrically and mechanically inclined, who do not have the interest of the company at heart and who do not have the ability to serve as maintenance foremen or the potentiality to become such. If a maintenance organization is free of men who do not measure up to these standards it will be successful.

Selection

The best assurance a company can have against hiring unqualified supervisors or workers is to establish a system of personnel selection aimed at obtaining and qualifying good men. It does not have to be elaborate and expensive. Even in its simplest form it can serve to determine whether a man is certified or, better yet, qualified to perform the duties that will be expected of him.

It is only good common sense to select men with the ability to do a job rather than to hire somebody just because you need another man. The risk in selecting supervisors, who actually control your profits, requires more than the catch-as-catch-can method. The day of selecting maintenance personnel on the basis of friendship, favoritism and nepotism has passed. Good selections mean lower turnover costs, better employee morale, better production and lower costs of training.

Good selection must be followed by good training.

Training

A training program must be designed to meet the needs of the company. The goals of such programs should be to improve the ability and efficiency of the men by giving them down-to-earth courses that will apply to their daily work routine. Many programs have failed because they were designed to teach theory alone rather than actual needs plus small doses of theory. However, it is important to expose men to basic theory if they are to learn the how and why of things.

Before a training program can be set up it is necessary to consider some of the problems that are likely to be encountered.

1. Will the program be sponsored by the company alone or in conjunction with a vocational school?
2. Who will attend the program?
3. What are the training needs?
4. What methods and techniques will be used?
5. Where will the training take place?
6. How will the courses be scheduled?
7. How large a group will be permitted to attend the courses?
8. Who will teach the course?

While the course of study for electricians and mechanics is pretty well determined by the work they perform—electricity, hydraulics and mechanics—the supervisor's training program is quite different. The supervisor deals mostly with people, not necessarily things, and also with personalities, not always technical know-how. There are a number of courses that can improve maintenance supervision and also prepare supervisors for possible advancements. The courses should include, among other subjects, the following:

1. Organization training.
2. Employment policy and procedure.
3. Maintenance policy and procedure.
4. Contract interpretation.
5. Report writing.
6. Communication policy.
7. Public speaking.
8. Human relations.

Before a training program can be successful it must have the full support of the operating department as well as the maintenance group. Anything short of complete support will result in failure of the training program.

Procedure

POLICY is the governing principle, plan or course of action followed by the maintenance department to achieve a sound and effective program. Practice is that part of the program designed to carry out the policy. Both policy and practice, however, are

REPORT

COPIES #: 1 – Mine Supt.
2 – Office Copy
3 – Section Foreman Copy

* FORM 1004

MINE: ....
SECTION: ....
SHIFT: 1 – 2 – 3

FEET OF ADVANCE ....
ESTIMATED TONNAGE ....

Cross Cut Dev. ....
Open Ends ....
Pockets ....
Wing ....
Rock Dusting ....
Bolts Installed ....
Bolts Recovered ....
First Aid ....

TIONS AT END OF SHIFT
NTRY

NOTES: ....

CODE	DELAY	EQUIPMENT	CO. NO. OR SERIAL NO.	CODE	DELAY
		Shuttle Car L			
		Shuttle Car R			
		Bolter			

Timbers: ....3', ...4', ...5', ...6'
Headers: ....
Roof Bolts: ....
Roof Bolt Plates: ....4 X 4....4 X 6
Bits Used; ....
Quantity Bolt: ....
Bolts Recovered: ....
Misc: ....

SECTION FOREMAN:
Signature: ....
Date: ....

FORM 1001

COPIES #: 1 – Repair Shop
2 – Mine Supt.
3 – Originator's File

SERVICE OR REPAIRS REQUESTED

To be filled in by Maintenance Department
Approved: ....
Worked On: .... Initials
Work Finished: .... Initials

MINE: ....
SECTION: ....

1. EQUIPMENT: .... Co. No. or Serial No.: ....

2. REPAIRS: ....

3. INSTRUCTIONS:
Suggested Material: ....

4. BEST TIME FOR REPAIRS: ....

5. REMARKS:
Length of section delay: ....

REPAIRS REQUESTED BY:
Signature: ....
Date: ....

SERVICE OR REPAIRS-REQUESTED FORM provides for listing equipment that needs service, nature of disability, situation under which trouble occurred and other necessary information. It is attached to the foreman's daily report.

REPAIRS & MAINTENANCE — EQUIPMENT REGISTER

RESP. NAME

DATE 19	UNITS N.T. COAL	BUDGET LABOR	BUDGET MATERIAL	BUDGET TOTAL	ACTUAL LABOR	ACTUAL MATERIAL	ACTUAL TOTAL	VARIANCE LABOR	VARIANCE MATERIAL	VARIANCE TOTAL
JAN.	99910	5095	5195	10290	5152	7444	12596	(57)	(2249)	(2306)
FEB.	82665	4216	4299	8515	2889	3709	6598	1327	590	1917
MAR.	94293	4309	4903	9212	4633	6710	11343	(324)	(1807)	(2131)
TO DATE	276868	13620	14397	28017	12674	17863	30537	946	(3466)	(2520)
APR.	89726	4576	4666	9242	3623	5785	9408	953	(1119)	(166)
MAY	92654	4725	4818	9543	5806	5719	11525	(1081)	(901)	(1982)
JUN.	80580	4110	4190	8300	4637	7004	11641	(527)	(2814)	(3341)
TO DATE	539828	27031	28071	55102	26740	36371	63111	291	(8300)	(8009)
DEC.										
TO DATE										

Note: Figures are hypothetical.
Parentheses denote red figure.

VARIANCE PER CENT. YEAR TO DATE
% LOSS ⟷ % GAIN

CODE	DESCRIPTION	RESP. NO.
914	14 BU Loader	991

REPAIRS AND MAINTENANCE EQUIPMENT REGISTER will show whether material usage and labor costs for the loader exceeded or was under the budget allowance.

controlled, in part, by the operating department and should have the approval of the department heads before any procedure is adopted. At this point it is essential that both the operating and maintenance departments confer with the top echelon of management for final approval.

Policy

Essentially, the maintenance policy must include provisions for accomplishing all the responsibilities assigned the maintenance department.

All work activity of the department can be divided into five classifications:

1. Preventive maintenance.
2. Repair.
3. Overhaul.
4. Construction.
5. Salvage.

These five work-activity classifications can be further refined and broken down into three categories:

1. Predictable Work—Preventive maintenance.

2. Unpredictable Work — Emergency repairs and troubleshooting.

3. Optional Work — Overhaul, construction and salvage.

Once the maintenance program has been broken down into its simplest form, definite policies can be established to assure effective maintenance procedures. Preventive maintenance, for example, requires that equipment be inspected at regular intervals, that routine repairs be made frequently and that equipment be properly lubricated. These requirements, along with many others, are adopted by the maintenance department. Moreover, policy designates how, when and where the requirements will be fulfilled.

Practices

Essentially, the goal in maintenance practices is to see that plans, schedules and work forces are sufficient to carry out the policies of the department.

Of the three categories previously listed, preventive maintenance offers the best means for achieving the greatest savings in maintenance costs. The paramount factors contributing to a successful preventive maintenance program are:

1. Selection of scheduled work.
2. Frequency of performing scheduled work.
3. Sufficient work force to complete scheduled work.

Emergency breakdowns or the unpredictable work cannot be controlled. Therefore, it is essential to provide sufficient troubleshooters to handle breakdowns, even if several breakdowns occur at the same time on one or more sections.

Overhaul, construction and salvage work can be contracted or performed by a work force maintained by the company. The problem is to determine whether or not it pays to contract the work or to maintain a working force to do it yourself.

Planning and Scheduling

WITH A WELL-ORGANIZED and sufficiently staffed maintenance force, prompt and effective maintenance can be accomplished. This also includes planning and scheduling of complete equipment overhauls, minor repairs and routine maintenance jobs, such as, inspecting and lubricating equipment at definite intervals.

Standards

Although industrial engineering has not yet been applied to maintenance in the mining industry to any degree, it does show promise of providing management with another tool to increase the effectiveness of maintenance and to reduce maintenance costs. Equipment and production techniques of today will influence the maintenance techniques of the future—and industrial engineering will play a major role.

Industrial engineering can serve maintenance organizations in a number of ways. These include, among others:

1. Simplification of work.
2. Improvement of shop layout and facilities.
3. Establishment of standard times for specific jobs.
4. Elimination of unnecessary job functions.

5. Increasing the effectiveness of planning and scheduling of all maintenance work.

On-the-Job Maintenance

The logical approach to on-the-job maintenance is to consider the necessary types of work to be performed. This leads to the "three-echelon" system, which breaks down as follows:

FIRST ECHELON — Inspection and minor running repairs at the face or in the pit make up first-echelon work. Normally, inspection is conducted by the section or pit electrician and mechanic, along with the operators, and the same men handle running repairs and adjustments.

Whatever the type of operation the basic principle is assignment of sufficient specialists to a unit or a group of units to keep break-downs to a reasonable minimum, since overmanning, in maintenance as in other activities, runs up the cost in excess of the benefits in additional lost-time reduction. Economical maintenance requires proper manpower.

SECOND ECHELON—Major inspections involving some opening of cases and enclosures, and also major repairs or replacement jobs done during idle periods make up second-echelon maintenance. Part of this work, such as, inspection and replacement of certain units and assemblies, may be done at regular intervals, and part will be done when necessary to avoid a potential breakdown or take care of an actual one.

THIRD ECHELON — Normally, third-echelon work involves complete overhaul of a machine on the basis of time, tonnage, yardage or hours worked. Underground units and small stripping units, as examples, normally are brought to the shop, or sent to an outside custom shop, for complete dismantling and rebuilding, and large stripping units are moved back from the face or out of the pit to prepared overhaul areas.

Aside from equipment, third-echelon work takes in such other activities as the repair of conveyor belts, large truck tires and similar items, for which some companies have special shops or shop sections. Others use custom shops or manufacturers' repair and service facilities.

Overhaul Scheduling

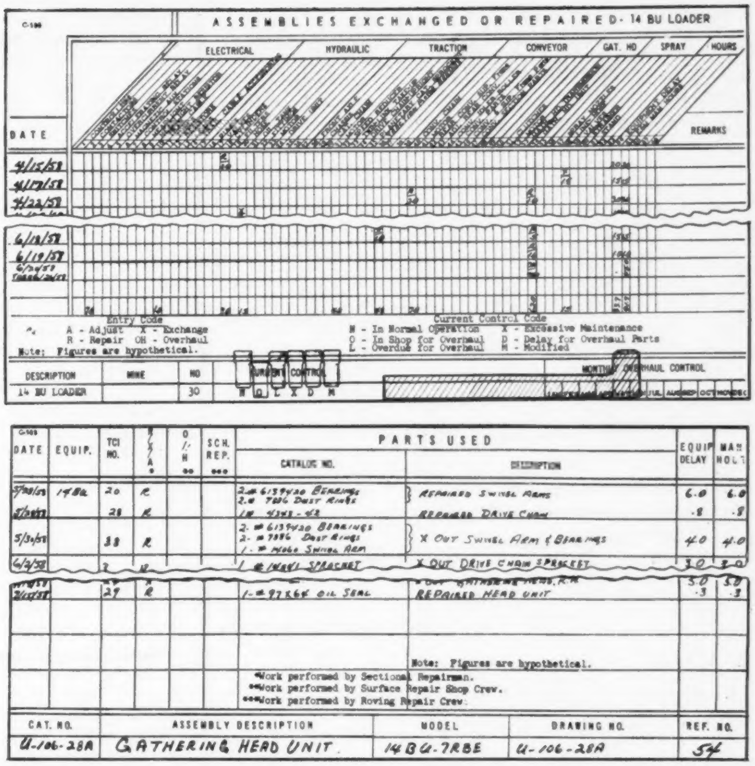
Five of the standards for determining when overhauling is necessary are:

1. **Elapsed time**—in weeks or months. In other words, machines are taken out of service at specific intervals for overhaul.
2. **Operating time** in hours or days.
3. **Tonnage or yardage handled.**
4. **Inspection.**
5. **Personal judgment.**

Each of these standards has its supporters among maintenance and operating men, though more of them seem to operate on the basis of a combination of inspection and hours operated or tonnage or yardage handled. Where the number of units is large, on the other hand, supporters of the elapsed-time standard point out that a rigid schedule is necessary to permit getting around to all the machines without jams resulting from two or three coming up for overhaul.

A sixth system is, in effect, no overhaul—or overhaul only at long intervals. Under this system, known as unit replacement, overhaul is accomplished by replacing assemblies, such as rear conveyors on loaders, crawlers on shovels and the like, removing the replaced assemblies to the shop for overhaul and storage until another assembly on another machine comes up for replacement.

What might be called a seventh system is practiced at at least one mine where the coal is low, belts are employed, and the difficulty of handling a major breakdown is much greater than in thicker coal. At this operation, each new panel is started with



ASSEMBLIES EXCHANGED OR REPAIRED CARD AND PARTS-USED CARD provide a historical-data record system. Reports and records are kept in the maintenance superintendent's office.

MONTH OF JUNE, 1958

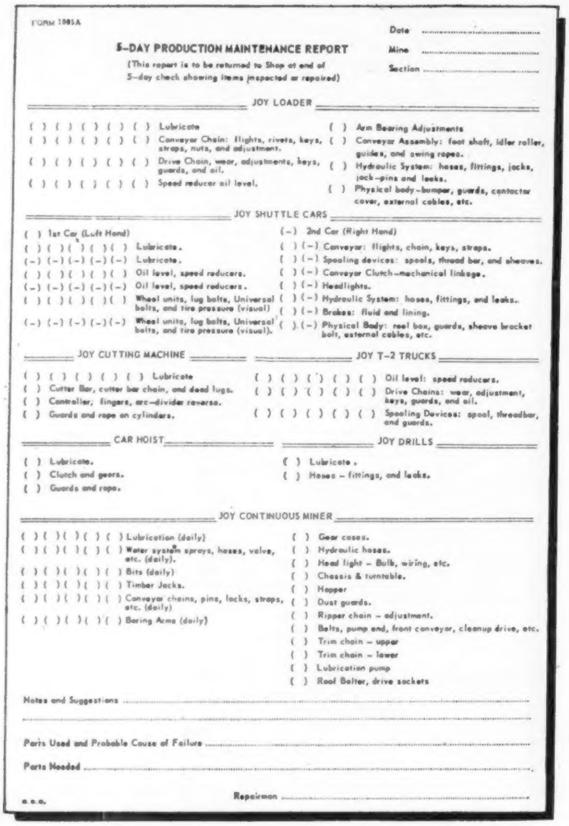
CRITICAL PARTS (LISTED ON EXCEPTION BASIS)

PART NO.	PART DESCRIPTION	QUANTITY: THIS MONTH REGULAR MAINT.	THIS MONTH OVER-HAUL	YEAR-TO-DATE REGULAR MAINT.	YEAR-TO-DATE OVER-HAUL	TOTAL	QUANTITY PER 1000 EQUIPMENT OPERATING HOURS: THIS MONTH	YR. TO DATE	COST PER 1000 EQUIPMENT OPERATING HOURS: THIS MONTH	YR. TO DATE
		–	–	–	–	–	–	–	–	–
14041	SPROCKET	1		1		1	3.33	.96	112.07	32.31
4343-1	DRIVE CHAIN LINK	1		4		4	3.33	3.33	2.57	2.57
4343-42	DRIVE CHAIN	1		1		1	3.33	.96	86.81	25.02
6139420	BEARING		4	3	4	7	13.33	5.83	182.55	79.84
7886	DUST RING		4	3	4	7	13.33	5.83	4.67	2.04
14060	SWIVEL ARM		1	2	1	3	3.33	2.50	342.08	256.82

COST PER 100 MACHINE OPERATING HOURS

ASSEMBLY NO.	ASSEMBLY DESCRIPTION	EQUIP. CLASS	EQUIP. NO.	LISTING DETERMINATE AMOUNT MACH.	PART	OPERATING MAINTENANCE THIS MONTH: LABOR LUBE INSP. & ADJ.	EXCH. ASSEM.	REPAIR	CRITI-CAL PARTS	DELAY COSTS	TOTAL	YEAR-TO-DATE OPERATING MAINTENANCE: LABOR LUBE INSP. & ADJ.	EXCH. ASSEM.	REPAIR	CRITI-CAL PARTS	DELAY COSTS	TOTAL	OVERHAUL: LABOR	CRITI-CAL PARTS	TOTAL
54	GATHERING	14BU	29	25.00	15.00			5.00	14.00	-	19.00		1.50	2.88	8.90	25.50	38.78	-	-	-
"	HEAD UNIT	"	30	"	"			10.50	20.15	49.50	80.15		-	9.20	26.45	37.80	73.45	11.15	18.27	27.42
"	" "	"	"	"	"															
"	" "	"	"	"	"															
"	" "	"	"	"	"															

REPORT OF SELECTED REPETITIVE MAINTENANCE COSTS by equipment assembly and part number is designed to pinpoint areas of repetitive equipment failure. Report is in two sections.



FORM 1005A

Date ....

Mine ....

Section ....

5-DAY PRODUCTION MAINTENANCE REPORT

(This report is to be returned to Shop at end of 5-day check showing items inspected or repaired)

JOY LOADER

( ) ( ) ( ) ( ) ( ) Lubricate
( ) ( ) ( ) ( ) ( ) Conveyor Chain: flights, rivets, keys, straps, nuts, and adjustment.
( ) ( ) ( ) ( ) ( ) Drive Chain, wear, adjustments, keys, guards, and oil.
( ) ( ) ( ) ( ) ( ) Speed reducer oil level.
( ) Arm Bearing Adjustments
( ) Conveyor Assembly: foot shaft, idler roller, guides, and swing ropes.
( ) Hydraulic System: hoses, fittings, jacks, jack-pins and leaks.
( ) Physical body-bumper, guards, contactor cover, external cables, etc.

JOY SHUTTLE CARS

( ) 1st Car (Left Hand)
( ) ( ) ( ) ( ) ( ) Lubricate.
(-) (-) (-) (-) (-) Lubricate.
( ) ( ) ( ) ( ) ( ) Oil level, speed reducers.
(-) (-) (-) (-) (-) Oil level, speed reducers.
( ) ( ) ( ) ( ) ( ) Wheel units, lug bolts, Universal bolts, and tire pressure (visual)
(-) (-) (-) (-) (-) Wheel units, lug bolts, Universal bolts, and tire pressure (visual).
(-) 2nd Car (Right Hand)
( ) (-) Conveyor: flights, chain, keys, straps.
( ) (-) Spooling devices: spools, thread bar, and sheaves.
( ) (-) Conveyor Clutch-mechanical linkage.
( ) (-) Headlights.
( ) (-) Hydraulic System: hoses, fittings, and leaks.
( ) (-) Brakes: fluid and lining.
( ) (-) Physical Body: reel box, guards, sheave bracket bolt, external cables, etc.

JOY CUTTING MACHINE

( ) ( ) ( ) ( ) ( ) Lubricate
( ) Cutter Bar, cutter bar chain, and dead lugs.
( ) Controller; fingers, arc-divider reverse.
( ) Guards and rope on cylinders.

JOY T-2 TRUCKS

( ) ( ) ( ) ( ) ( ) Oil level: speed reducers.
( ) ( ) ( ) ( ) ( ) Drive Chains: wear, adjustment, keys, guards, and oil.
( ) ( ) ( ) ( ) ( ) Spooling Devices: spool, threadbar, and guards.

CAR HOIST

( ) Lubricate.
( ) Clutch and gears.
( ) Guards and rope.

JOY DRILLS

( ) Lubricate.
( ) Hoses - fittings, and leaks.

JOY CONTINUOUS MINER

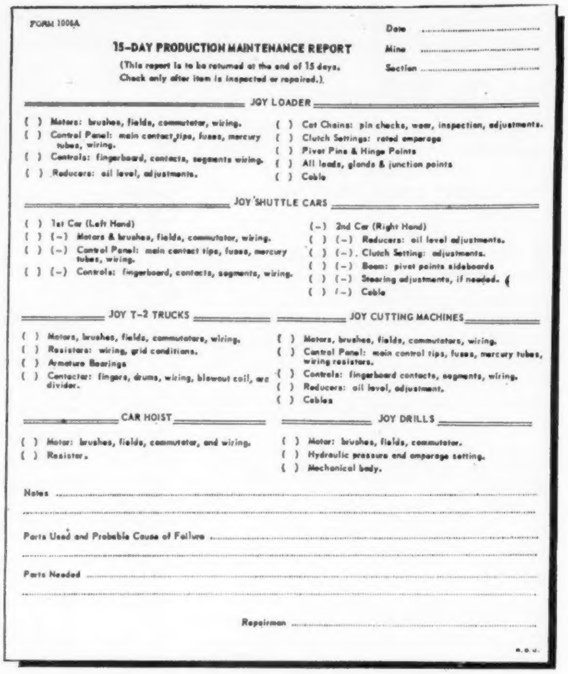
( ) ( ) ( ) ( ) ( ) Lubrication (daily)
( ) ( ) ( ) ( ) ( ) Water system sprays, hoses, valve, etc. (daily).
( ) ( ) ( ) ( ) ( ) Bits (daily)
( ) ( ) ( ) ( ) ( ) Timber Jacks.
( ) ( ) ( ) ( ) ( ) Conveyor chains, pins, locks, straps, etc. (daily)
( ) ( ) ( ) ( ) ( ) Boring Arms (daily)
( ) Gear cases.
( ) Hydraulic hoses.
( ) Head light - Bulb, wiring, etc.
( ) Chassis & turntable.
( ) Hopper
( ) Dust guards.
( ) Ripper chain - adjustment.
( ) Belts, pump end, front conveyor, cleanup drive, etc.
( ) Trim chain - upper
( ) Trim chain - lower
( ) Lubrication pump
( ) Roof Bolter, drive sockets

Notes and Suggestions ....

Parts Used and Probable Cause of Failure ....

Parts Needed ....

a.e.a. Repairman ....



FORM 1006A

Date ....

Mine ....

Section ....

15-DAY PRODUCTION MAINTENANCE REPORT

(This report is to be returned at the end of 15 days. Check only after item is inspected or repaired.).

JOY LOADER

( ) Motors: brushes, fields, commutator, wiring.
( ) Control Panel: main contact tips, fuses, mercury tubes, wiring.
( ) Controls: fingerboard, contacts, segments wiring.
( ) Reducers: oil level, adjustments.
( ) Cat Chains: pin checks, wear, inspection, adjustments.
( ) Clutch Settings: rated amperage
( ) Pivot Pins & Hinge Points
( ) All leads, glands & junction points
( ) Cable

JOY SHUTTLE CARS

( ) 1st Car (Left Hand)
( ) (-) Motors & brushes, fields, commutator, wiring.
( ) (-) Control Panel: main contact tips, fuses, mercury tubes, wiring.
( ) (-) Controls: fingerboard, contacts, segments, wiring.
(-) 2nd Car (Right Hand)
( ) (-) Reducers: oil level adjustments.
( ) (-). Clutch Setting: adjustments.
( ) (-) Boom: pivot points sideboards
( ) (-) Steering adjustments, if needed.
( ) (-) Cable

JOY T-2 TRUCKS

( ) Motors, brushes, fields, commutators, wiring.
( ) Resistors: wiring, grid conditions.
( ) Armature Bearings
( ) Contactor: fingers, drums, wiring, blowout coil, arc divider.

JOY CUTTING MACHINES

( ) Motors, brushes, fields, commutators, wiring.
( ) Control Panel: main control tips, fuses, mercury tubes, wiring resistors.
( ) Controls: fingerboard contacts, segments, wiring.
( ) Reducers: oil level, adjustment.
( ) Cables

CAR HOIST

( ) Motor: brushes, fields, commutator, and wiring.
( ) Resistor.

JOY DRILLS

( ) Motor: brushes, fields, commutator.
( ) Hydraulic pressure and amperage setting.
( ) Mechanical body.

Notes ....

Parts Used and Probable Cause of Failure ....

Parts Needed ....

Repairman ....

a.e.a.

FIVE- AND FIFTEEN-DAY INSPECTION REPORTS detect trouble before breakdowns occur and also provide record of inspections of vital components.

equipment that has been completely overhauled, the crew merely transferring from a worked-out panel and leaving the machines to the maintenance force.

Contract Maintenance

Since outside shops serving a region or a large part of the industry have an opportunity to install more facilities and employ more men with the necessary skills because of the larger volume of business, they are increasingly able to offer major-repair and overhaul advantages, especially to organizations not large enough to support full-scale facilities. Shops now in existence, along with facilities offered by equipment manufacturers, are set up to give speedy, efficient service in overhauling and repairing loaders, continuous miners, shuttle cars and other underground equipment, and bulldozers, small shovels, engines and similar equipment for strip mines; plus conveyor belts, tires, motors and other components. Bit sharpening, drill sharpening and other service shops round out the list.

Reports and Records

CONTROL OF THE TOTAL COST OF COAL PRODUCTION is contingent to a marked degree upon effective control of equipment maintenance. Maintenance progress is difficult without proper reports and records. Even though paper work is involved, careful study of the types and number of forms will reduce it to a minimum —and will make that minimum more valuable.

The objective of a maintenance cost-control program is primarily to provide adequate detail to permit pinpointing specific parts for study. This program also should permit follow-up to determine if remedial action is effective and, in addition, should provide information for determining comparative merits of equipment from different manufacturers. Further, it should provide adequate information on which to base decisions with respect to retiring equipment nearing the end of its economic maintenance life. A long-range objective should be to provide a method of determining labor performance on maintenance.

Equipment Register

Maintenance records are tailored to the class of equipment. These records (see illustrated repairs and maintenance equipment register) show budgeted repairs and maintenance cost, actual cost, and variance for the month and quarterly year-to-date totals.

Control data are recorded on visible-edge cards which are filed in book units. Separate cards are maintained for each class of equipment for each mine. Units of production or net tons of coal handled by the respective classes of equipment are recorded. Maintenance costs are detailed as to labor and material, and the budgeted as well as actual costs and variances are shown.

A colored signal along the edge of each card indicates percentage variance for the year-to-date, favorable or unfavorable.

Historical-Data Record System

Specific historical data are recorded on two general types of cards which, normally, are filed in the maintenance superintendent's office. The assemblies exchanged or repaired card (see illustration) is an example of the master or accumulator record. The headings on this card vary with the type of equipment. Across the top are headings for data and name of assemblies or components classified as to major categories, such as, electrical, hydraulic, traction, conveyor, spray, etc., as well as equipment-delay hours and maintenance man-hours. A separate card is provided for each major equipment item.

A parts-used card accompanies the historical data record. This card provides space for date, equipment classification and number and, by symbol, whether the work was performed by the sectional repairman, surface shop crew or the roving repair crew.

Parts used are detailed by catalog number and description. Delay time and maintenance hours involved also are recorded. Small hardware, such as, bolts, cap screws, lock washers, etc., are not recorded.

Parts-Failure Report

Another possible service obtainable from records is a report that will pinpoint areas of repetitive equipment failure. It is divided into two sections and is prepared on a

monthly basis. One section summarizes by assembly the cost per 100 equipment operating hours of regular maintenance, detailed by labor, critical parts used and delay costs, and cost of equipment overhaul, also is detailed by labor and critical parts used.

The other section of the report involves specific parts used. The initial detail is on a selective basis when the cost per 100 equipment operating hours for an individual piece of equipment exceeds a predetermined amount set by engineering studies.

Production and Delay Reports

To simplify the various forms and to reduce writing a delay-account code for mine and preparation equipment should be established. The mine code should provide numbers for all delay sources. The preparation-plant code should provide numbers for each equipment item.

The daily delay or operating report is a must. It shows what the mechanical and electrical failures were and how much time was lost with each. Also, these reports may be expanded to show other delays and their causes to permit appropriate action. Thus, they become running time studies of machine performance, and provide invaluable data for eliminating the causes of reduced efficiency.

This report may be rather simple and concentrate on production and delays only. Or, it may include details on labor, parts used and a description of work done. For example, a delay report may provide space for recording such information as:

Machine Data — Number, type and position.

Delay Account — Code, unit-assembly or event.

Cause of Delay—Code, reason for delay.

Material Used—Quantity, code and part number.

Delay Time—Total downtime and loading time lost.

Repair Cost—Labor and material.

Equipment Checklist

This form, filled out by section and plant foremen, lists the code numbers and equipment items. Space is provided at the right or left of each equipment item to indicate whether it is in good condition or whether it needs attention. Space also is provided to permit foremen to explain why equipment needs repair.

Work-Needed Report

To attain fully the goal of preventing breakdowns, some form of reporting on work or adjustments needed is a necessity. It permits reporting a part that seems likely to fail so that the necessary steps may be taken to repair or replace it on the next idle shift.

Work needed may be reported either on the front or back of the regular delay form, or it may be reported on a special form. Where it is entered on a special form, special handling may be necessary to make sure that both the repair foreman and the superintendent, for example, get the data they need without delay. Or, the forms may be made out in duplicate or triplicate and routed accordingly.

Where separate forms are used, the original naturally goes to the repair foreman, with perhaps a copy to the superintendent. In some instances, the form includes space for reporting on when the work needed was done, with or without copy to the superintendent, as a further means of insuring that prompt action is taken.

Inspection Report

As a second means of preventing breakdowns, a number of mining operations have instituted inspection reports. The frequency of such reports can vary from daily to monthly or longer, with a week or a month the most common. The reports are derived from special inspections of a varying degree of thoroughness, and normally involve going into certain cases and the like. In other words, the machine is given a more thorough examination than would normally be involved in a quick daily once-over.

Inspections may be made by the regular section electricians or mechanics, or by special men from the mine or central shop. These men at the same time can make certain adjustments and repairs, and can note larger jobs that may require taking the unit out of service.

A recent newcomer to mine maintenance personnel is the electrical-mechanical inspector. His primary duties are to conduct and plan inspection schedules for all equipment, make out equipment reports and submit them to responsible operating and maintenance heads, to make sure that work orders are carried out and completed as scheduled, and to recommend when certain equipment should be taken out of service for overhaul.

FIVE- AND FIFTEEN-DAY PRODUCTION MAINTENANCE REPORTS—These basic inspection reports permit detection of trouble prior to breakdowns. They are issued regularly by the maintenance supervisor and must be returned promptly by repairmen conducting maintenance on idle shifts. The items listed (see report form) are intended to cover most areas of possible equipment trouble. The inspector must indicate that action has been taken on all items, either listing his OK or noting that he has initiated corrective action. The maintenance supervisor, after receiving the form at the end of the inspection period, conducts frequent follow-up checks to determine the quality of the action taken.

The work on the 5- and 15-day reports can be done any time during the designated period, except on items which need daily attention.

Each equipment item is listed on the report so that it will be checked at the proper time interval. The 5- and 15-day periods are suggested for routine operations. The maintenance supervisor may choose time periods more suitable.

Weekly and Monthly Delay Summaries

These reports provide a periodic summary of the progress and effectiveness of the preventive maintenance program. Weekly reports give a quick breakdown of the amount of delays by section (day and night shifts) and the frequency for each delay source. Total delays in minutes, percentage of work time lost and the amount of tonnage lost complete the standard weekly summary report.

The monthly delay summary is a more comprehensive report than the weekly. It gives a broader view of the over-all program and enables supervisors to spot weak or trouble areas in the maintenance structure. Information contained in the monthly summary is obtained from the weekly reports.

Cost Records

There is a growing trend toward keeping a complete record of repair parts and labor unit by unit. Labor in this instance normally means special labor beyond the usual attention given by the section mechanic — in other words, shop and special labor required for major repairs and overhauls. Paper work is increased but the accurate unit record provides, among others, these advantages.

1. Excessive expenditures may signal waste or loss of parts sent into the section for running repairs, as well as lack of lubrication, abuse of the machine by operators, and so on.
2. Rising expenditures may signal the need for overhaul earlier than normally scheduled to prevent excessive machine breakdowns.
3. Consistently higher expenditures for one type of machine, compared to another of equal capacity, may make it desirable to standardize on the lower-maintenance unit, other things being equal.
4. Data on the value of special materials —for example, stainless steel—can be readily obtained to show if they are worthwhile or not.

For maximum convenience, unit cost records may be kept on cards designed for rotary or other quick-viewing files. The data for the records naturally comes from requisitions for parts and materials submitted by the foremen or other responsible officials, and from reports on parts and labor expended by the repair foreman. Naturally, also, summaries of the unit records should be made at regular intervals—perhaps monthly —for the superintendent and other officials having jurisdiction.

Filing

The type of report will, in many instances, indicate who should file it—for example, a report on work completed by the repair foreman, or on lubrication by the head of the lubricating crew, if one is employed. Daily delay and operating reports may be filed by the foreman or the operator of the key machine, with some arguing for the machine operator since the foreman may not be with the machine at all times. Operator reports, if that is the system, naturally should be filed through the foreman, who will check and countersign.

FORM 1010
Sheet #1

SUMMARY OF DELAYS

Date ....
Mine ....

SECTIONS	(1)			(2)			(3)			(4)			TOTAL	
TOTAL WORK TIME FOR MONTH (MIN.)														
1. LOADER MECH.	F	MINS.	%	F	MINS.	%	F	MINS.	%	F	MINS.	%	F	MINS

1. Gathering Arms
2. Lubricate
3. Conveyor Chain
4. Tramming Chain
5. Cat. Chain
6. Speed Reducer
7. Hydraulic Hose
8. Boom Swing Rope
9. Hydraulic Pump
10. Hydraulic Control Valve
11. Idler Sprocket
12. Jacks
13.
14.
15.
16.

TOTAL LOADER MECH.

LOADER ELEC.
1. Splices, Trailing Cable
2. Power
3. Resistance
4. Coil
5. Grounded
6. Contactors
7. Pump Motor
8. Traction Motor
9.
10.
11.

TOTAL LOADER ELEC.

2. CONTINUOUS MINER
1. Set Bits
2. Water Hose
3. Spline Shaft
4. Ripper Chains
5. Boring Arms
6. Trim Chain – Top
7. Trim Chain – Bottom
8.
9.
10.

TOTAL CONTINUOUS MINER

3. SHUTTLE CAR MECH.
1. Lubricate
2. Conveyor Chain
3. Conveyor Clutch
4. Bent Flight
5. Hydraulic Hose
6. Hydraulic Pump
7. Brakes

F – Denotes Frequency

FORM 1010
Sheet #2

SUMMARY OF DELAYS

SECTIONS	(1)			(2)			(3)		
TOTAL WORK TIME FOR MONTH (MIN.)									
3. SHUTTLE CAR MECH.	F	MINS.	%	F	MINS.	%	F	MINS.	%

8. Master Cylinder
9. Lug Bolts
10. Flat Tire
11. Wheel Unit
12. Universal Joint
13. Reel Fouled
14. Reel Chain
15. Cable Guide
16. Drive Shaft
17. Tie Rods
18. Thread Bar
19. Steering Arms
20.
21.
22.

TOTAL SHUTTLE CAR MECH.

SHUTTLE CAR ELEC.
1. Power
2. Splices, Trailing Cable
3. Grounded
4. Coil
5. Contactors
6. Traction Motor
7. Pump Motor
8. Leads
9.
10.
11.

TOTAL SHUTTLE CAR ELEC.

4. CUTTER MECHANICAL
1. Cutter Bar
2. Tramming Chain
3. Feed Rope
4. Hydraulic Hoses
5. Steering Jacks
6. Tires
7. Sprocket
8.
9.
10.

TOTAL CUTTER MECHANICAL

CUTTER ELECTRICAL
1. Splices Trailing Cable
2. Grounded
3. Contactors
4. Traction Motor
5. Cutter Motor
6.
7.
8.

TOTAL CUTTER ELECTRICAL

F – Denotes Frequency

FORM 1010
Sheet #3

SUMM[ARY OF DELAYS]

SECTIONS	(1)			(2
TOTAL WORK TIME FOR MONTH (MIN.)				
5. COAL DRILL MECH.	F	MINS.	%	F	MINS

1. Hose
2. Pump
3.
4.
5.

TOTAL COAL DRILL MECH.

COAL DRILL ELEC.
1. Splices, Trailing Cable
2. Switch
3. Motor
4.
5.
6.

TOTAL COAL DRILL ELEC.

6. ROOF BOLTER MECH.
1. Drive Mechanism
2. Tires
3. Clutch
4.

TOTAL ROOF BOLTER MECH.

ROOF BOLTER ELEC.
1. Splices, Trailing Cable
2. Motor
3. Controller
4.
5.
6.

TOTAL ROOF BOLTER ELEC.

7. OTHER DELAYS
1. Accident on Section
2. Safety Meeting
3. Key Operator Absent
4. Pre-Shift Examination
5. Engrs. Set Spads
6. Mantrip Late
7. Lunch, Men not Floated
8. No Coal
9. Ramp
10. Wrecks
11. No Empties
12. Hoist Pulled Out
13. Hoist Rope Broken
14. Airdox or Powder
15. Equipment Conflict
16. Change Out Machines
17. Move to New Setup
18. Scale Top
19. Timber
20. Handling Supplies
21. Roadways

F – Denotes Frequency

FORM 1010
Sheet #4

SECTIONS

TOTAL WORK TIME FOR MONTH (MIN.)

7. OTHER DELAYS (Cont.)
22. Slate Fall
23. Equipment Stuck
24. Power
25. Shot Failure
26. Smoke
27. Water
28. Move Cable
29. Rock Dust
30.
31.
32.
33.
34.
35.

TOTAL OTHER DELAYS

TOTAL MECH. DELAYS

TOTAL ELEC. DELAYS

GRAND TOTAL DELAYS

NOTES
1. Total Days Operated
2.
3.
4.

F – Denotes Frequency

REMARKS:

SUMMARY OF DELAYS is used to analyze downtime characteristics, total cost and reasons for delays. Records are maintained by the accounting department or a maintenance clerk. These records keep management informed in all phases of maintenance.

Where several machines make up a unit, there may be a question as to whether reports should be required of the several operators—for example, cutters, shuttle-car drivers, etc. Among other things, such reports might be valuable by focusing operator attention on the need for good maintenance and care in operation. Practically, however, one report, especially if prepared by or with the cooperation of the foreman, usually can provide the necessary information.

Reports on work needed likewise may be filed by the operator, the foreman or the section mechanic, working with each other.

Whatever the number and scope of the various reports, the rule should be a practical system.

Spare Equipment

ONE METHOD OF ALLEVIATING effects of major breakdowns is keeping spare units on hand, provided the cost of such spare units can be kept within reasonable limits.

Limitations

On large units is it impracticable to buy, say, two 30-yd shovels, one to substitute for the other when it breaks down.

With smaller units, such as underground loading machines, a much-greater opportunity exists for keeping spares on hand without excessive investment. General practice is to provide a spare for each 3 to 5 major production units, such as, loaders, cutters, continuous miners, shuttle cars, etc.

Basically, the number of spares depends upon conditions and particularly on the extent to which preventive maintenance reduces major breakdowns. Time necessarily is involved in getting the inoperative machine out of the way and the new one in, regardless of how close the spare may be. If breakdown time can be kept below that figure without exception, there theoretically would be no need for spare units, except to maintain output during overhaul periods.

But since breakdowns have an annoying habit of causing lengthy delays, there is an opportunity for the spare units, and that opportunity increases as breakdown frequency and time increases. However, there is a drawback. Investment in equipment—and in parts and labor to take care of breakdowns—also increases. The conclusion is that preventive maintenance on the working units is the real goal, and will reduce the need for spare equipment and also the breakdown cost.

A second factor determining spare unit practice is the overhaul schedule. With intervals of 6 mo to 2 yr on major underground units and on certain surface units, and with overhauls requiring up to a month or more, spares are a necessity if production is to be maintained at a certain level. Usual practice is to take an underground machine out of the section, or a small portable unit out of the strip pit, and send in the spare unit. Certain underground mines, however, follow the practice of keeping extra completely equipped sections and transferring the crews for the overhaul pe-

riod, on the basis that moving men is less costly than moving equipment.

Standardization

Standardization of mining equipment, of course, has its limits, and complete standardization would make it difficult to work in new types of machines and thus take advantage of their characteristics. But with fewer types of equipment, including components such as motors and the like, there is a much greater opportunity for learning all about the equipment and how to handle it. Also, repair-part inventories are reduced and the problem of receiving, storing and issuing parts is simplified.

Unit Changeout

The most recent advance in mine maintenance is the unit changeout system. Although this system involves a rather large initial outlay of capital the results after the program gets under way show a substantial decrease in machine downtime and replacement of parts.

The success of this program depends on five major factors:

1. **Organizing the program.**
2. **Evaluating the equipment** to determine within safe limits the average life of the various units that are to be changed out periodically.
3. **Supplying an adequate number of spare units** and replacement parts.
4. **Allocating a sufficient number of men** to carry out the program, both in the shop for rebuilding the units and inside the mine for changing them out.
5. **Keeping an accurate record** of each equipment item.

Once the program is in operation, accurate records must be kept to insure its success. Records, for the most part, consist of a master equipment chart. This chart lists all equipment and its location, and provides space for recording information on the units of each machine that are included in the changeout program. The information includes frequency of changeout, when they were changed last and when they are to be changed out again.

Shops

Central Shops

Central shops generally are defined as establishments where work beyond the removal and replacement of parts and assemblies is done. It is difficult, however, to be precise as to what main or central shops are, since they vary widely in goals, scope of work handled, and equipment. Normally, however, their main business is major repair and overhaul, and to facilitate this they usually include machine tools and other equipment not found in mine shops. On the other hand, main shops can function as mine shops, and they may also in some instances, include facilities for manufacturing repair parts and even complete equipment units.

Where several mines are operated by a single company, the question arises as to whether to have a main shop at each operation or a big central shop for all. The trend seems to be toward centralizing main-shop work in one plant, especially where good highway and rail connections are available. The advantages include:

1. Less duplication of equipment and facilities, in turn providing an opportunity for adding extra facilities in the man shop without increasing overall expenditure.
2. An opportunity to provide additional repair and maintenance skills because the volume of work is sufficient to warrant employment of certain specialists.
3. An opportunity for increasing efficiency because of the greater volume of work in one place.
4. Less duplication of parts and supply inventories, and consequently a reduction in inventory, as a result of concentration of operations.

SHOP TYPES—Main Shops may include types aside from the general overhaul and repair units devoted to machine reconditioning. Examples are: conveyor-belt shops, wheel-reclamation and welding shops, truck-tire shops, mine car shops and so on. Such shops may be separate or may be incorporated into the main shop via separate rooms, bays and the like, and, of course, are warranted only when the volume of specialized work is sufficient to make them practical.

SHOP LAYOUT—Since size of operation, type of equipment, type of work done and other factors vary widely, no prescription can be given for a typical main or central shop. A summary of layout and facilities for three specific shops, however, is as follows:

STRIP-MINE SERVICE CENTER—L-shaped shop, warehouse and garage structure, with 66x215-ft garage as the base of the L; next a 59x32-ft warehouse; and completing the upright of the L, a 59x84-ft machine shop. Thus, the warehouse is conveniently located between the machine shop and the garage. The garage is fitted with 10 rollup doors, and handles the maintenance and repair of all gasoline, butane and diesel equipment and pumps (but not motors), as well as serving as the headquarters for the maintenance of two small walking draglines. Extra engines and some heavy spare parts, including some rear end transmissions, are kept in a fenced-off enclosure in the garage, which is equipped with a 2-ton hoist on an overhead track.

The warehouse includes a 25x25-ft partitioned section in one corner serving as the electrical shop. Warehouse facilities include convenient outdoor storage for heavy shovel parts while lighter parts that can be brought inside—via a 5-ton chain hoist mounted on overhead rails—are stored on the floor. Bins, of course, are provided for the smaller items.

The machine shop does work for the garage, electrical shop and the field force, and is equipped with three radial drills—one large and two small; horizontal lathe, 20-ft bed, 36-in swing; 12-in lathe, 18-in utility saw, shaper, bolt machine (up to ¾ in), three hand-welding machines, automatically controlled gas-cutting unit, automatic continuous welding machine, two 5-ton and two 2-ton chain hoists.

DEEP-MINE CENTRAL SHOP—Three-building establishment, all connected with doors wide enough and high enough to permit passage of portable cranes, thus avoiding the use of heavy overhead cranes and hoists; windowless Quonset construction, with fluorescent lighting. Unit functions equipment are:

Building 1, 40x100 ft, rebuilding shuttle cars, loaders and continuous miners; steel work benches, two bench drills, vises, two 300-amp portable welders, gas-welding equipment, air-operated impact wrenches and portable drills, test panel for mercury tubes.

Building 2, 40x100 ft, rebuilding rubber-tired cutters, rubber-tired coal drills, roof drills and other mining machinery; wall-type work benches, special floor-type work bench for repairing shuttle-car wheel units, two welding machines, cable vulcanizer, cable-conductor welder, and 150-kw rotary converter for DC test power.

Building 3, double Quonset 60x80 ft plus single Quonset 60x40 ft, building up and machining parts for mines and preparation plants; wheel press; 20-in, 48-in and two 24-in lathes, milling machine, radial drill, 20-in shaper, bolt threader, slotter, metal-cutting band saw, bit cutoff machine, blacksmith forge, air compressor for the three buildings, two degreasers, heating boiler, welding machine, and floor controlled bridge crane across lathe bay; also toilet and shower facilities in 20x20-ft room.

DEEP AND STRIP SHOP—Though designed primarily for the complete rebuilding of underground equipment, one shop also handles certain work for the company's strip operations. Size of the two-story building is 213x95 ft inside, and it includes offices and a supply room. A modified assembly-line procedure is followed, with types of machines assigned to certain bays, and parts removed to service bays for reconditioning before return to the unit. An outside cleaning station is a major contribution to quality and efficiency.

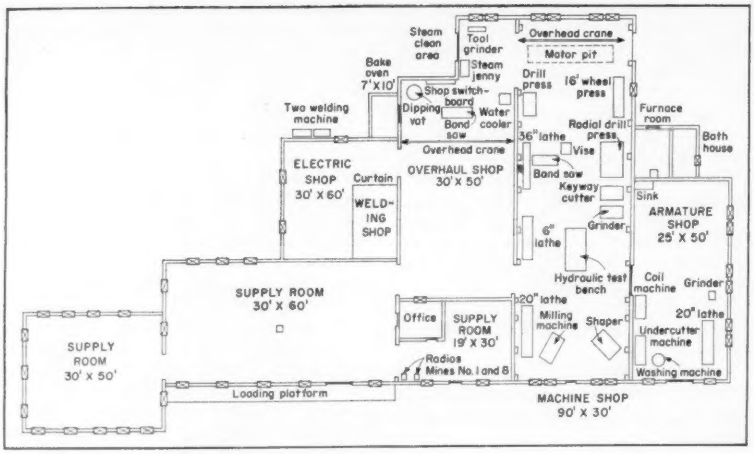
While, as noted, shops vary widely in character and facilities, certain practices and equipment lead to higher quality of work at lower cost. These include: good light, convenient lockers and work benches, special benches and stands for certain work (shuttle-car wheels, for example), supply depots in the shops themselves or at least close at hand, hoisting equipment for lifting and moving anything heavy, including such things as shafts into lathes, and power-operated tools—impact wrenches, etc. Cleaning and degreasing equipment contributes greatly to comfort and efficiency.

Other facilities included in the design of a main shop are a foreman's office, supply room, showers and lockers for personnel and separate section for electrical department.

While design and shop facilities influence quality of work and efficiency, the need for qualified supervisors and skilled workers also must be considered. A good shop must not only be well equipped but must have men that can do the work.

Mine Shops

Although a few deep mines make a practice of maintaining machines up to the stage of semi-overhaul in the working section, lack



CENTRAL SHOP AND SUPPLY HOUSE combination speeds overhaul work and reduces inventory. Shop is laid out so that specialized work can be performed in assigned work areas. Shop design plays an important part in a maintenance setup.

of space, the difficulty of doing welding, light and coal dust, among other things, normally dictate the transfer of major repairs, replacement of assemblies and semi-overhaul to shops maintained for that purpose. Some of these conditions do not prevail in strip pits, and consequently there is a greater opportunity for doing second-echelon work away from the shop. And with large stripping units, the only practical way to work on them is in the field in special repair areas, though some components and assemblies are processed in the shop or shops. In preparation, also, the nature of the plant and equipment also dictates doing a major part of the work on the job, though parts and assemblies may be removed for shop repair and return.

DEEP-MINE SHOP LOCATION — Distance and whether or not the equipment must be hoisted up slopes or shafts are among the factors involved in location of deep-mine shops. A third is facilities for quick moving of units from the face to the shop and back, such as, special transporters. Where good transportation facilities exist, and hoisting is not involved, it may be possible to locate mine shops on the surface and thereby get the advantage of space, natural light and the like, including convenience, at a somewhat smaller expenditure. But where the distance is great, and where hoisting is involved, there are strong reasons for locating the shops underground. With proper planning and design, they can be made almost as convenient as surface shops —and as efficient—and have the major advantage of being closer to the actual working sections.

Moving the shop as the mining location shifts also is possible with certain types of mining—contour in particular, as well as auger. Some such operations use small prefabricated buildings mounted on skids or trucks as shops or supply houses or both, moving the unit or units as needed as the mine opening moves around the outcrop.

STRIP-MINE SHOP LOCATION — Central location and convenient access from highways, both on the property and off, are among the considerations involved in locating strip-mine shops. Frequently, these considerations result in the shop being located with the other mine facilities, such as, the mine office and the preparation plant, especially since big units are necessarily repaired in the field, and trucks, tractors and small units can be brought in under their own power or by the use of transporters, even when they are not required to come to the preparation plant regularly. An exception might be a truck garage and shop where the trucks haul to field stations or to rough cleaning plants moving coal to central plants by rail after rough cleaning.

SHOP FACILITIES — Even the simplest deep-mine shop for major repairs, replacement of assemblies and the like should be equipped with a pit, hoisting facilities and a parts store room, plus the necessary special tools required for the work done. Parts-cleaning equipment should be installed if possible to speed up this operation and facilitate subsequent work.

At the other end of the scale, mine shops may be large and elaborate and able to handle everything up to complete dismantling and reassembly of all types of machines. One shop of this type, located near the bottom of the hoisting shaft, includes high-intensity lighting, a general repair section with two pits plus overhead cranes and small hoists, two bays for shuttle-car service with hoisting facilities, an office, cabinets for parts, a room for repair and servicing of shuttle-car wheels and hydraulic-jack units with monorail crane, and a cleaning recess with permissible-type steam cleaner supplemented by a refuse stall.

Tools include saw, floor-type drill press, vises, bench drills, floor grinders, hydraulic press, welding machines, and portable electric and air grinders. Facilities also include 32 tool cabinets built into the walls, and a compressor.

IN-PLANT FACILITIES—Though not a part of shops, certain permanent facilities of a shop type serve very useful purposes in certain maintenance applications. Examples are compressed air and welding gas lines and outlets in preparation plants, and arc welders in preparation plants and strip shovels. Time saving is the major advantage.

Mobile Repair Units

The repairman's jeep, with space for carrying parts and supplies and lockers or compartments for tools, has become a fixture at many underground mines because of the speed with which it can deliver both men and materials to the scene of a breakdown. Similar units also speed up the work of wiremen, bratticemen and other service workers. Other mobile maintenance units include welding trucks — gas and electric — where there is an opportunity to use such equipment in fresh air.

DEEP MINES — Skid-mounted "maintenance centers" are among the newer types of mobile repair units. Designed particularly for trackless mining and moved by hitching them to a shuttle car, the centers consist of 4x5x12-ft steel tanks with flat tops providing bench surfaces for work. Among other advantages, a supply of spare parts is always within 100 ft of the face.

For bringing machines to fresh-air locations, and for other purposes, including moves, crawler-mounted pullers or carriers have been found very useful at a number of mines, especially in low coal. And where machines must be moved long distances, such as loaders, miners and shuttle cars to main shops, lowbed transporters speed up the operation and save wear and tear on the units.

STRIP MINES — Mobile maintenance equipment at one strip operation includes the following, aside from greasing and fuel trucks:

Small-tool truck for all types of small hand tools and parts normally required on maintenance jobs.

Large-tool trailer for transporting heavy tools required in major jobs on big stripping units.

Flat trailers for moving wood blocks, cribbing and the like.

Special heavy-duty trailer for hauling buckets and shovels up to 100 tons.

Small-parts truck.

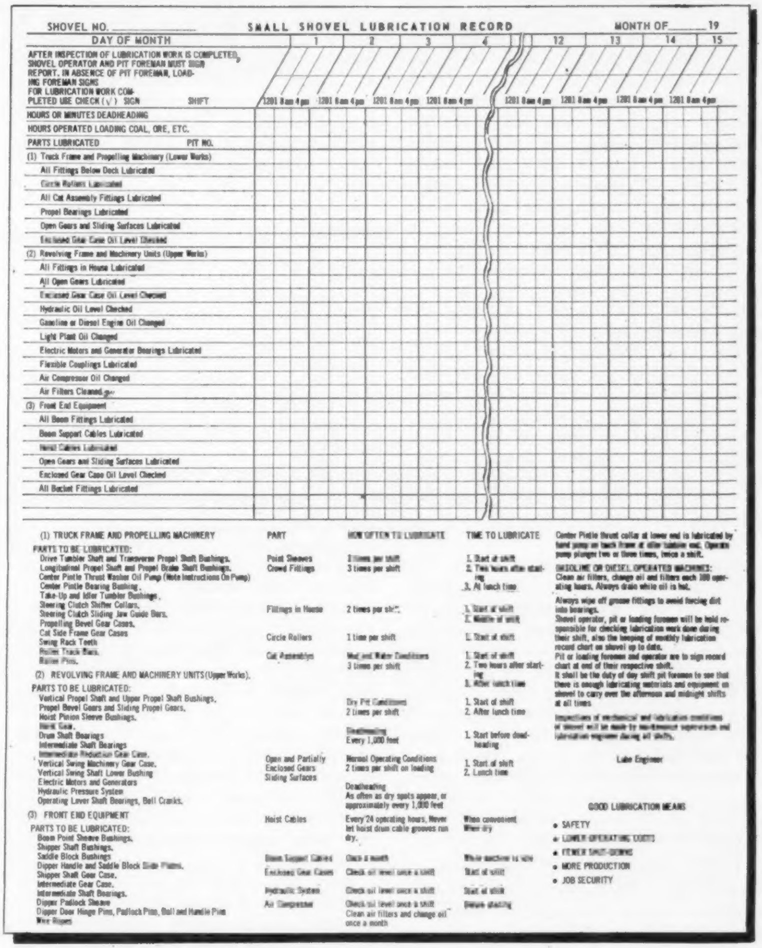
Truck-mounted crane with boom sufficiently long to handle all lifting jobs necessary in maintaining 40- to 50-yard shovels.

Welding trucks.

COMMUNICATION — If for no other reason, a good communication system from the face or pit to the main office and repair shop normally will pay for itself through reduction in breakdown losses alone. In strip pits, two-way radio is one of the answers, and includes certain mobile units in the superintendent's car, the repair foreman's car or truck, and the cabs of the key stripping units, among others. A good telephone or trolley system yields the same results in deep mines.

Lubrication

A GOOD LUBRICATION SYSTEM will contribute greatly to reducing maintenance costs (labor and material) and production breakdowns.



SHOVEL NO. ______ SMALL SHOVEL LUBRICATION RECORD MONTH OF ______ 19

DAY OF MONTH	1	2	3	4	12	13	14	15
AFTER INSPECTION OF LUBRICATION WORK IS COMPLETED, SHOVEL OPERATOR AND PIT FOREMAN MUST SIGN REPORT. IN ABSENCE OF PIT FOREMAN, LOADING FOREMAN SIGNS. FOR LUBRICATION WORK COMPLETED USE CHECK (√) SIGN — SHIFT	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm
HOURS OR MINUTES DEADHEADING								
HOURS OPERATED LOADING COAL, ORE, ETC.								
PARTS LUBRICATED — PIT NO.								
(1) Truck Frame and Propelling Machinery (Lower Works)								
All Fittings Below Deck Lubricated								
Circle Rollers Lubricated								
All Cat Assembly Fittings Lubricated								
Propel Bearings Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
(2) Revolving Frame and Machinery Units (Upper Works)								
All Fittings in House Lubricated								
All Open Gears Lubricated								
Enclosed Gear Case Oil Level Checked								
Hydraulic Oil Level Checked								
Gasoline or Diesel Engine Oil Changed								
Light Plant Oil Changed								
Electric Motors and Generator Bearings Lubricated								
Flexible Couplings Lubricated								
Air Compressor Oil Changed								
Air Filters Cleaned								
(3) Front End Equipment								
All Boom Fittings Lubricated								
Boom Support Cables Lubricated								
Hoist Cables Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
All Bucket Fittings Lubricated								

(1) TRUCK FRAME AND PROPELLING MACHINERY

PARTS TO BE LUBRICATED:
Drive Tumbler Shaft and Transverse Propel Shaft Bushings.
Longitudinal Propel Shaft and Propel Brake Shaft Bushings.
Center Pintle Thrust Washer Oil Pump (Note Instructions On Pump)
Center Pintle Bearing Bushing.
Take-Up and Idler Tumbler Bushings.
Steering Clutch Shifter Collars.
Steering Clutch Sliding Jaw Guide Bars.
Propelling Bevel Gear Cases.
Cat Side Frame Gear Cases
Swing Rack Teeth
Roller Track Bars.
Roller Pins.

(2) REVOLVING FRAME AND MACHINERY UNITS (Upper Works).

PARTS TO BE LUBRICATED:
Vertical Propel Shaft and Upper Propel Shaft Bushings.
Propel Bevel Gears and Sliding Propel Gears.
Hoist Pinion Sleeve Bushings.
Hoist Gear.
Drum Shaft Bearings
Intermediate Shaft Bearings
Intermediate Reduction Gear Case.
Vertical Swing Machinery Gear Case.
Vertical Swing Shaft Lower Bushing
Electric Motors and Generators
Hydraulic Pressure System
Operating Lever Shaft Bearings, Bell Cranks.

(3) FRONT END EQUIPMENT

PARTS TO BE LUBRICATED:
Boom Point Sheave Bushings.
Shipper Shaft Bushings.
Saddle Block Bushings
Dipper Handle and Saddle Block Slide Plates.
Shipper Shaft Gear Case.
Intermediate Gear Case.
Intermediate Shaft Bearings.
Dipper Padlock Sheave
Dipper Door Hinge Pins, Padlock Pins, Bail and Handle Pins
Wire Ropes

PART	HOW OFTEN TO LUBRICATE	TIME TO LUBRICATE
Point Sheaves Crowd Fittings	2 times per shift 3 times per shift	1. Start of shift 2. Two hours after starting 3. At lunch time
Fittings in House	2 times per shift	1. Start of shift 2. Middle of shift
Circle Rollers	1 time per shift	1. Start of shift
Cat Assemblys	Mud and Water Conditions 3 times per shift	1. Start of shift 2. Two hours after starting 3. After lunch time
	Dry Pit Conditions 2 times per shift	1. Start of shift 2. After lunch time
	Deadheading Every 1,000 feet	1. Start before deadheading
Open and Partially Enclosed Gears Sliding Surfaces	Normal Operating Conditions 2 times per shift on loading	1. Start of shift 2. Lunch time
	Deadheading As often as dry spots appear, or approximately every 1,000 feet	
Hoist Cables	Every 24 operating hours. Never let hoist drum cable grooves run dry.	When convenient When dry
Boom Support Cables	Once a month	While machine is idle
Enclosed Gear Cases	Check oil level once a shift	Start of shift
Hydraulic System	Check oil level once a shift	Start of shift
Air Compressor	Check oil level once a shift Clean air filters and change oil once a month	Before starting

Center Pintle thrust collar at lower end is lubricated by hand pump on truck frame at idler tumbler end. Operate pump plunger two or three times, twice a shift.

GASOLINE OR DIESEL OPERATED MACHINES: Clean air filters, change oil and filters each 100 operating hours. Always drain while oil is hot.

Always wipe off grease fittings to avoid forcing dirt into bearings.

Shovel operator, pit or loading foremen will be held responsible for checking lubrication work done during their shift, also the keeping of monthly lubrication record chart on shovel up to date.

Pit or loading foremen and operator are to sign record chart at end of their respective shift.

It shall be the duty of day shift pit foremen to see that there is enough lubricating materials and equipment on shovel to carry over the afternoon and midnight shifts at all times.

Inspections of mechanical and lubrication conditions of shovel will be made by maintenance supervision and lubrication engineer during all shifts.

Lube Engineer

GOOD LUBRICATION MEANS
- SAFETY
- LOWER OPERATING COSTS
- FEWER SHUT-DOWNS
- MORE PRODUCTION
- JOB SECURITY

LUBRICATION EFFICIENCY is promoted by definite scheduling and reporting, as with this form for small shovels. The advantages of this type of report cannot be over-emphasized.

Responsibility

Attainment of an effective lubrication system requires acceptance of perhaps three responsibilities.

1. Selection of lubricants and lubrication equipment.
2. Establishment of a lubricating schedule.
3. Application of lubricants.

Lubricant Selection

Selection of lubricants normally falls on the maintenance department, though the importance of lubrication might well warrant the employment of a lubrication engineer — at least where a company operates several mines and a large number of producing units.

The recommendation of the equipment manufacturer is the starting point in lubricant selection, with the second major source of data the service departments of the oil companies. A third source of information, provided proper records are kept, are the lubricating and delay reports, which may indicate that a change in type is necessary. When all the preliminaries are completed, lubricants then should be bought on performance rather than on general representations, and the rule should be the highest possible quality in view of the penalties now suffered as a result of equipment breakdowns.

STANDARDIZATION—Too many types of oils or greases lead to confusion, misapplication, contamination and loss. Careful study of the lubricating problem will show, in many instances, that a lesser number of types of high quality will do the job, since the variety of lubricants available include many with the necessary spread in characteristics fitting them to several applications.

As an example of what standardization can accomplish, one large stripping organization, also operating a large and modern preparation plant, cut the number of lubricants from 29 to 9, as follows.

	Types Before	Types After
Motor oil, heavy-duty detergent	2	1
Gear oil, all enclosed gear cases	4	1
Antifriction-bearing grease		1
Plain-bearing grease	5	1
Open gears	3	2
Cable dressing	5	1
Compressor oil	3	1
Hydraulic oil	7	1
Totals	29	9

Scheduling

Scheduling, with attendant reports and records, is perhaps one of the most-vital elements in efficient lubrication, and here again the responsibility rests on the maintenance department or the lubrication engineer.

An efficient lubrication program depends upon definite scheduling of the work, accompanied by definite instruction as to the type of lubricant to be used. This means a written document for the information and guidance of all who have anything to do with lubrication, and this document may also serve as a report on work done. Tags enclosed in plastic envelopes may, for example, be tied to tractors, with one side of the tag showing points to be lubricated, type of lubricant to be used, and when lubrication is to be done, and the other side serving as a record of lubrication performed. Similarly, more comprehensive schedules may be posted in strip shovels and preparation plants, or supplied to foremen and mechanics underground.

Application

A key item in lubrication is getting the job done. Responsibility may be placed on the maintenance department alone or may be shared by the maintenance department and the machine operators and/or section or pit mechanics and electricians. The lubricating system varies with the type of machine and when and where it is used. The three general systems are:

1. Hand lubrication. This usually involves grease guns or spout-type or other oilers for fluid lubricants. Where this is the practice, lubrication normally is handled by either the machine operator or the mechanic or electrician assigned to the machine or section, or by a special oiler, as with large stripping units. Lubrication can be combined with inspection and running maintenance, as with belt conveyors underground, for example.

Hand lubrication involves more transfers and containers, as a rule, and makes for more complicated distribution in addition to increasing the risk of contamination.

An improvement in small hand gun reloading is the use of manufacturer-filled grease cartridges, which reduces the reloading time and eliminates contamination.

2. Lubricating Trucks and Special Crews. Such trucks are used both underground nd at strip pits. Hand lubrication may be desirable for several reasons including low working height, cramped quarters, or the type of unit, such as, a belt conveyor. However, since individuals with other duties frequently are called upon for lubrication under this system, the chance of human error is greater. Hand lubrication also increases the chances of contamination, and may require stopping the units during the working periods, thus reducing output.

The preceding are among the reasons why a number of mines have placed responsibility for lubrication on special crews and have provided them with lubricating trucks. A

typical underground truck usually is operated by a crew of two men, who visit all units in the mine or a section of the mine once a day on the off shift. The truck usually is equipped with tanks for two types of lubricants, with a third tank for hydraulic oil, and may be provided with hoses for blowing fittings, motors and the like as necessary with air from the compressor used in dispensing the lubricants. Where the truck is track-mounted and offtrack equipment is employed, the offtrack equipment may be brought to the loading station once a week, for example, for thorough inspection and lubrication, with lubrication by hand at other times. The truck crew also fills lubricant containers for hand lubrication.

Trucks for strip equipment also may include fuel-dispensing equipment. One such unit comprises a gas-powered compressor, lubricating pumps, four lubricating hoses on reels, and four fuel drums with the necessary hoses. Air pressure is used for dispensing fuel as well as lubricants, and the unit serves tractors, drills and other smaller mobile units.

3. Centralized Automatic Lubrication. Minimum manpower and positive lubrication at all times are among the reasons for the rise in use of centralized automatic lubricating systems in coal mining. These systems dispense either grease or oil — more usually grease—and among other advantages reduce the chances for contamination to almost nothing, since the lubricants usually are dispensed from the original containers or if not, with a minimum number of transfers.

Reports and Records

Unless somebody checks, adhering to an efficient system in lubrication, as in all other activities around the mines, is practically impossible. This means reports and records which, even though they involve paper work, provide the basis for intelligent operation and control.

Reports may be rather simple in nature, merely recording that a certain machine was lubricated on a certain date. An important item in any report, however, is whether certain bearings refused to take lubrication or took too much, since this is a signal that trouble is probably in the making. A rise in quantity used on each machine or in each application is a further signal that machine condition is deteriorating, or that certain parts need attention. And if experience has shown that adequate lubrication can be secured with certain quantities of materials, figures on quantities used also will reveal waste and loss through contamination or otherwise.

Rated Voltage

IT IS DIFFICULT to overemphasize the importance of rated voltage at the motor terminals as a factor in maintenance—and in unit production. DC motors, for example, tend to slow down almost in proportion to voltage drop, and slow-acting machines, plus frequent cable and armature failures, tend to result in don't-care operators.

When trailing cables or motor conductors are subjected to high current overloads—one result of reduced voltage—the resistance of the copper conductors increases, the cable drop rises, the voltage to the machine is further reduced, the machine automatically calls for more current with added heating, and the vicious circle continues—possibly to the point of cable or motor failure. Under extreme conditions, copper can be heated to 600 F or higher, at which point it will burn even if nothing else fails before.

Maintaining Voltage

The causes of low voltage include:

1. Substations too far from the working face (see article on electric power for recommendations on maximum distances).
2. Excessive cable length.
3. Inadequate feeder and return capacity.
4. Cables too small.

In addition, excessive heating results from the following:

1. Layering on reels or in piles decreasing cable rating because of inadequate air circulation.
2. Inadequate or no overload protection. Properly rated fuses or properly set circuit breakers should be used.

Regular voltage checks therefore become a necessity in preventive or production maintenance, and may even warrant the use of recording-type instruments at strategic locations. Otherwise, the section electrician may well be charged with the responsibility for making regular checks. And to make these checks effective, a program of moving up substations and beefing up feeders and returns as necessary must be followed. This might well be the responsibility of the chief electrician, maintenance supervisor or electrical engineer.

Since even under the best of conditions heat is generated when current flows in conductors, and the higher horsepowers now being employed in the same or only slightly larger space aggravate the problem, the best in motor and cable insulation should be employed, such as asbestos-fiber compounds, silicone and the like. Blowing motors is a well-established method of keeping them cool in certain types of service, and cooling by water jackets is coming into the picture for certain motors subjected to the most-severe duty, as on continuous miners.

Cable Maintenance

Even with rated voltage, delivery of the necessary power to the operating machines usually involves a trailing cable of some type. Aside from low voltage and overload, the major causes of cable failure, particularly underground, are:

1. EXCESSIVE TENSION. — Install spring-type shock absorbers, keep proper tension on reel, adjust reel to prevent back spooling.

2. MECHANICAL DAMAGE — Avoid running over cables, replace broken sheaves and guides, avoid pinching cable.

In the event a cable fails in spite of all precautions, reducing the time lost requires quick restoration of the service. Some ways of doing this are:

1. Use of compression connectors and special hand or power tools for quick connection of the power and ground wires to save time. Special portable welding equipment also is used to make splices electrically. A fairly common failure is trying to keep a cable with too many splices or otherwise in less than top-grade condition in service. The cost of the delays in some instances will repay the cost of a new one in as little as 2 to 4 days.

2. Use of spare cables to permit quick replacement of the entire cable. An alternative with at least certain types of equipment is the use of sectionalized cables, which not only are easy to install but also lend themselves to the quick replacement of a new section for one that has failed.

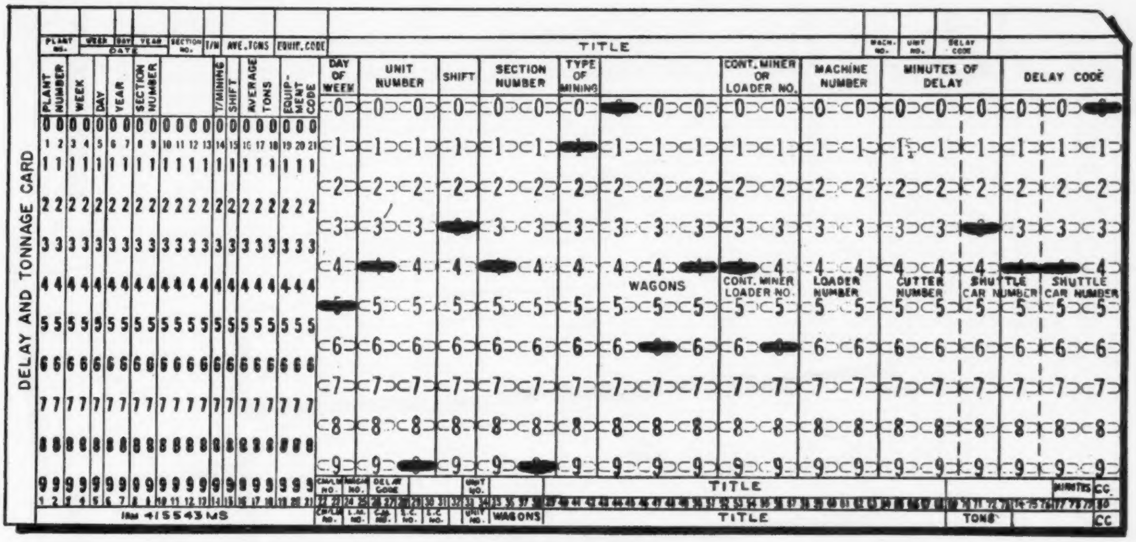
Temporary splices should be kept to a minimum. One rule allows six, after which the cable is removed and sent to the shop for rebuilding by permanent welded or compression-connected splices and vulcanizing. Some mines remove the cable with a lesser number of splices.

Maintenance Materials

HARDSURFACING PRODUCTS are an example of materials that cut maintenance cost by increasing the life of machines and parts subject to wear, reducing the number of replacements and consequently saving not only in parts and materials but also in labor for replacement.

Examples of the other materials and parts that may be employed to lengthen machine and part life, reduce breakdown time and cut the cost of maintenance include:

1. Stainless and other alloy steel, aluminum and so on for strength, light weight and corrosion resistance in mine cars, truck bodies, stripping dippers, cages and skips, and so on. Light weight, provided there is the requisite strength, in itself reduces the maintenance load, or light weight with high strength permits building up parts without increasing total weight, thus reducing the chances of failures.
2. Stainless steel, manganese-steel and bronze for reducing wear and corrosion in coal screening and other coal-handling process.
3. Special alloys, bronze, rubber, other corrosion- and abrasion-resisting materials for pumps, valves, fittings and other equipment handling water and water with various solids.
4. Use of lime, by means of automatic feeding equipment, in wet-preparation plants where acid is a problem to reduce corrosion.
5. Cast iron, alloy, asbestos-cement, lined or plastic pipe for mine and other water lines to resist acid.
6. Rubber, tile, sprayed and sand-cement and other corrosion- and abrasion-resisting materials for tanks and storage bins. Some companies have made complete bins of steel-supported glazed tile to resist the effects of abrasion and corrosion.
7. Glass, stainless steel and other we r-resisting materials for chutes, conveyor bottoms.
8. Aluminum, protected-metal and other weather-resistant siding and roofing for preparation plants and other structures.
9. Protective coatings and paint where needed.
10. Silicone, asbestos and other long-lived heat-resistant insulation for electrical equipment.



PUNCH CARDS provide a new method of controlling inventory and reducing supply costs. Great variety can be had in the manner in which information is collected. Automatic machines do the processing.

Profitable Supply Control

Since 1955

Automatic office machines more widely used to control supply inventory and cost, and provide more accurate records and reports in less time and with less manpower.

Cost of parts and materials increased, resulting in strong emphasis on close inventory control.

Methods of storing and handling supplies improved.

Ahead to 1965

Trend to central supply houses probably will be the rule for companies with more than one mine.

Supply inventory may decrease but dollarwise parts and materials probably will increase.

Bulk purchasing of supplies to grow to take advantage of reduced prices.

Requisitioning of supplies to be better controlled with emphasis on where parts are used and why.

INCREASED INVENTORIES resulting from the use of more and more mining and preparation equipment, higher costs of parts and materials and a faster turnover of supply items make a good supply system an economic necessity in the industry.

Cost of parts and materials make up a large part of the cost of coal. An average of 85c per ton goes for supplies. The low, usually at the smaller operations, is as little as 40c per ton or less and the high is over $1. It is quite possible that the average supply cost per ton of coal will increase considerably within the next few years.

The need for a good supply system, close inventory control and more detailed reports on the use of parts and materials by machine and by working sections is becoming more of a must than a routine function.

An adequate flow of parts and materials is required to keep machines and men working. A good supply system promotes efficiency and lowers cost in five major ways:

1. Machines and men are able to produce more by the elimination of interruptions resulting from lack of parts and materials.
2. Inventory is controlled and kept to a minimum.
3. Parts and materials are received, stored and delivered at minimum cost.
4. Waste prevention and loss of parts and material are controlled.
5. Fewer office workers are needed to process incoming and outgoing supplies and to make reports.

Control Systems

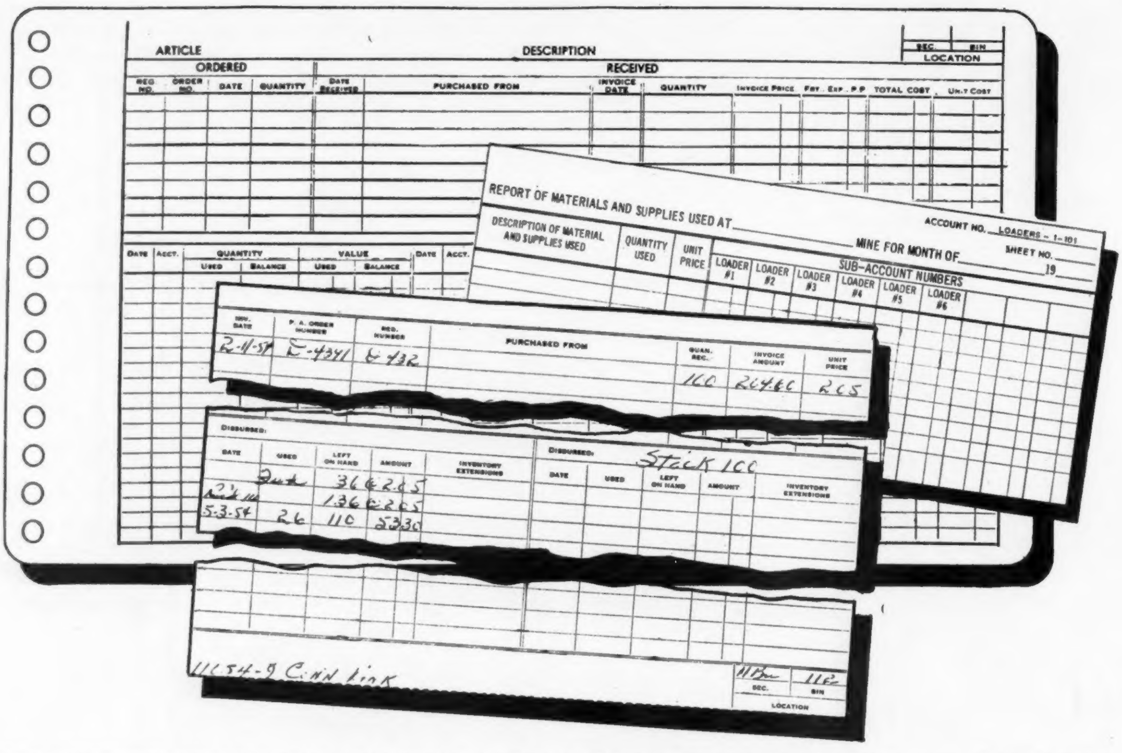
The use of automatic office machines, such as computers, sorters, verifiers, etc., provide better control of inventory and supply cost. Lower office cost and the elimination of time-lag in preparing reports also are important features.

Several types of automatic office machines are available for these purposes. They have remarkable speed and flexibility.

An integrated data-processing system using set methods and machines can provide considerable savings in the supply setup and also in the overall mine operation. Supply-cost reports produced by machines can provide a foundation on which to built a cost-reduction program. The machines not only produce reports which make fixing of cost responsibility possible but the reports disclose where action is necessary to stay within objectives. Action can include such things as elimination of waste, development of better methods, improvement of maintenance techniques, requests to suppliers and manufacturers of better materials, dissemination of pertinent information and so on.

Perpetual Inventory

Companies have largely settled on the "perpetual" system of inventory control. Basically, it provides a running record of



PERPETUAL-INVENTORY CARDS (top and bottom) are for loose-leaf ledger and tray-type files. A complete record of supply receipts, quantity on hand, disbursements and costs requires only two forms, thus simplifying inventory and minimizing clerical work. Monthly use report (center right) lend themselves to summaries by account of function numbers, or by individual units to keep track of parts costs.

(1) quantity and cost of units and materials received, (2) quantity and cost of units and material issued and (3) quantity remaining on hand at all times.

This information is contained on cards at each bin or on tray-type cards filed in loose-leaf ledgers or metal cabinets.

FILE CARDS—The file-card system is the handiest and surest method of inventory control. It reduces the possibility of running short of supplies through failure to note that the time for reordering has come.

Inventory cards may be made up specifically by a mining company to meet its own needs, or cards, files and systems may be purchased from specialists in business machines and business records, who can, if desired, provide forms and equipment for even punch-card tabulating and record-making where the number and volume of supply items is large.

The accompanying illustrations show two types of cards provided by business-record specialists. One is designed for ledger use and the other for tray-type files. Both give a complete record of each supply item.

RUNNING RECORDS—The system provides a running record of activity in supplies, and also an easy means of making periodic summaries of use. Most companies prefer to have all supply items listed in the system. However, when there are exclusions, such as timber, it becomes necessary to make sure that (a) the items are not overbought, (b) that the quantity is not permitted to drop below the danger point, and (c) that data are supplied for the periodic supply-use and inventory reports.

REORDER AND USE INDICATORS—To facilitate reordering and filing reports on the use of parts, supplies and materials, cards with "flags" or colored tabs can be used.

A green plastic tab, for example, on the card may be slid to the center the first time an item is issued in a monthly or other report period, and a red tab on the opposite side also may be slid to the center as an indication that the item is to be reordered when the next requisitions on the purchasing department are prepared. The flags make it unnecessary to check each card.

Supply Receiving

A new receiving system (*Coal Age*, September, 1957, p 73) eliminates delays in reporting receipt of shipments, which result in the delay of payment of invoices with the possibility of missing out on discounts. All necessary papers are prepared in a single writing by means of a portable register. It consists of four parts:

White—Invoice clerk's copy with freight or express bill attached.

Green—Cost clerk's copy.

Blue—Requisitioner's acknowledgment.

Salmon—Requisitioner's copy for filing.

Physical Inventory

Accurate records of receipts, cost and use are essential for wise and economical use of supplies. Regardless of the supply-control system employed, it should be supplemented by an actual physical inventory if supply cost and production time are to be reduced. Inventories are usually taken at 6- and/or 12-mo intervals.

Records and Reports

THE STANDARD "supply-distribution report" and detailed reports on the use of parts and materials by machine and by working section are increasing in importance. For convenience, each equipment class or mining function is provided with an account number.

ACCOUNT NUMBERS—A standard coding system for automatic office machines must be developed to provide adequate descriptions of the various supply transactions so that costs can be accumulated on specific items and developed into general group totals.

The supply-cost code should contain sufficient digits to permit cost reports to be expanded, if necessary. More accuracy, greater detail and a lower cost per report will result. The code usually is in three parts or more. Numbers from each part must be selected and combined to describe a transaction.

For other systems the daily or other delay reports using account numbers provide —at least by inference—sufficient information to determine whether supplies are being used properly and economically. On the

other hand, the more detailed system requires definite and positive information to prevent waste and loss through abuse and carelessness.

ORDER FORMS—Order forms, reports and records are essential for the proper evaluation of supply use. Nothing should be issued without an order, properly signed, stating what is wanted and where it is to be used. For a check and appropriate action, summaries of supply use should be prepared at regular intervals for the information and use of mine and operating management.

MONTHLY DISTRIBUTION REPORTS—This is one form of report to mine and operating management. Where more detailed data are desired the form or forms may be expanded to show items charged out to each machine, to each working section and to each general function, thus indicating whether abuse is running up parts cost or whether certain sections are taking more supplies than necessary.

SUPPLY-COST REPORT—The supply-cost report should be so detailed that supply costs can be analyzed from final total to subtotals and specific items. It should show the cost per ton of coal (dollar value) and quantities for specific accounts, and should be done for the month and the year to date.

SUPPLY COST SUPPLEMENT—This report shows the cost of various machine subassemblies which is broken down into costs of individual parts. The part name, quantities for the month and year to date, dollar amounts for the month and year to date, units of issue and unit prices are included in this report.

SUPPLY COST COMPARISON—This report is prepared at the end of the year. It shows cost-account numbers and their costs per ton for each mine or section. It is extremely effective in improving performance of the various mines or sections. Comparisons show good and bad points and promote the exchange of ideas and new objectives.

CENTRAL-SHOP COST REPORT—The overhaul report is prepared monthly for work done in the central shop. It shows the total cost, cost charged to each mine and the cost charged to each machine on which work was done. These charges are all subdivided into costs for labor, overhead and supplies for the month and year to date.

COMPANY SUPPLY CHARGES—This is a resume of charges against supply costs by various organizations within the company each week. Each mine is covered individually. The purpose of the report is to assist in daily cost accounting at the mine and to provide a means of detecting errors in charges.

USE REPORT—This report shows machine part numbers and descriptions, quantities used at each operation, total quantities used by the company as a whole and the average unit prices. It is prepared quarterly for the quarter and year to date.

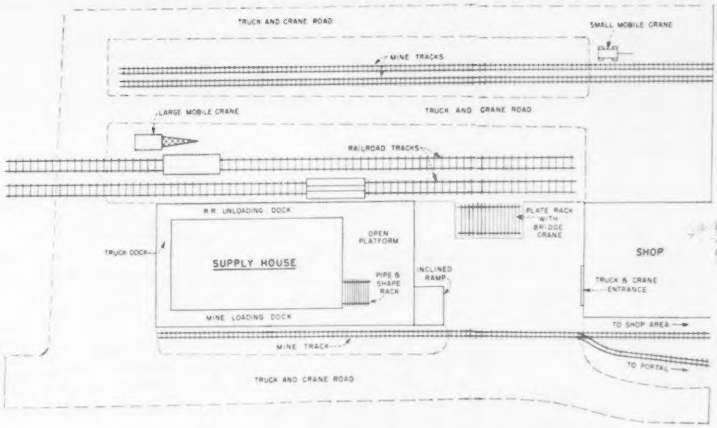
SUPPLY STOCK REPORT—The part number and description, unit of issue, old balance, receipts, issues, new balance, quantity on order, total quantity on hand and on order, the established inventory level, quantity due out, and the quantity above or below requirements are shown in this report. It is used to adjust inventory and purchase quantities.

SPECIAL REPORTS—These reports may be required of certain officials and mine employees. For example, a single carbide-tipped cutter bit can cost $1.25 or more and, therefore, some operators feel that it is necessary to keep records on the amount used daily and the number on hand. Similar records could be required for other small and relatively costly items, such as, roof bolts, steel ties—the fast-moving items.

To wrap up a detailed record system, it naturally should show transfer of certain materials from one working area to another, thus guarding against possible loss through carelessness or buck-passing. And if such things as timber are salvaged for use elsewhere, the records should show how much came out of a particular section and where it went as a means of gaging, among other things, the effectiveness of a salvage program.

Inventory Control

THE QUESTION most often asked about supply inventory is: "What should be car-



Storage Layout

CONVENIENCE, EASY ACCESS AND PROTECTION feature yard designed for truck and mobile-crane operation with receiving and loading docks on three sides. The principles illustrated include:

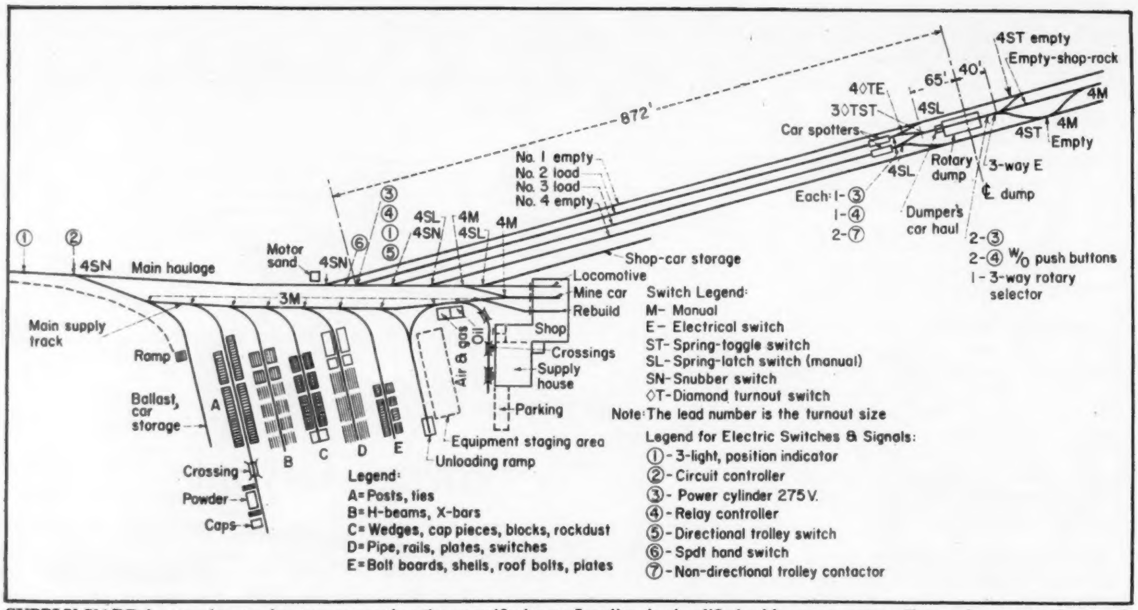
1. Receiving and loading dock completely surrounding the warehouse. This is a practice that can be followed if desired, but it may not always be necessary to surround the supply house with docks, though provision should be made for sufficient dock space both for receiving and for loading mine equipment. The docks in the setup illustrated are at the right height for receiving material from railroad cars or trucks, and for loading materials into mine equipment without excessive lifting or lowering.

2. Open storage planned so that as heavy material is unloaded it can be placed so that it is convenient for loading into mine equipment. Roads are located so that mobile cranes can be used for unloading railroad cars or for lifting heavy items out of storage into mine equipment. These same roads permit unloading such items as mine props and timbers directly to the mine trucks if desired.

3. Use of power-operated handling equipment. The mobile crane, with various attachments, including clamshell for sand and gravel, and fork for props, rails and the like, or other mobile handling units materially reduces labor and also the hazards involved in handling heavy parts and materials. With a fork-type grab, for example, two men can load a car of ties in less than 1½ hr. Aside from cranes, mobile handling units include motorized wheelbarrows, motorized high-lift, bucket-type loaders and carriers, high-lift fork trucks, crane trucks and so on.

4. Open platform with inclined ramp provides open storage for certain parts and materials and also makes it easier to get equipment, such as, shuttle cars, loaders and the like out of railroad equipment and down to mine-track level. Handling of heavy items on the platform can be done with the mobile cranes, or the platform can be equipped with crane rails and a hoist. An alternative is a crane track extending out of the supply house to the platform both for handling materials on the platform, or for moving them inside to floor storage.

The plan illustrated also shows an open plate storage with traveling crane and hoist. Plates are stored on edge between stanchions.



SUPPLY YARD has tracks running to areas assigned to specific items. Loading is simplified with power crane. Four mine-car tracks permit storing or blending of raw coal. Supply house and shop are strategically located.

ried in terms of dollars and cents?" Actually there is no one answer. Inventory, if too high, means that money will lie idle. On the other hand too low an inventory can mean increased production delays and higher production costs. Among other things, the level of supplies at individual mines depends upon mine location and size. Inventories range from as little as \$25 to \$30 per ton of daily capacity up to \$150 or more per ton at mines remote from manufacturing and distribution centers. The average appears to be in the neighborhood of \$50 to \$60 on hand per ton of daily capacity.

Control Factors

The inventory level involves a fair amount of personal judgment based on experience and an analysis of parts and supply use in relation to time for normal replenishment. Some of the factors involved in arriving at a solution include:

1. Cost of item or a class of items in relation to production cost increases incurred if the item is not on hand when needed—for example, spare armatures or motors. For instance, how much, at the most, would a rotor failure on the main shaker-screen motor involve in payments for nonproductive labor, for power for ventilaton and pumping during the production interruption, and so on? And would the cost be reduced if a complete motor was on hand instead of only the rotor? Or should the possibility of a stator failure be the controlling one and thus dictate keeping a complete motor ready for replacement?

2. Rate of use in relation to time required to reorder and get delivery of replacements. Experience normally will indicate the rate at which, say, controller fingers of a certain type are used. If new supplies could be secured in a month, then the maximum on hand at any one time theoretically would be a month. Or, the total use in, say 6 mo,

LOOSE-LEAF CARDS for the perpetual-inventory system are kept in ledgers to permit easy checking.

might be so small that it would pay to keep that much stock on hand to avoid the extra clerical and other effort involved in ordering more frequently—not to mention discounts for large orders.

3. Central warehousing vs. warehouses at individual mines. Where one company operates several mines, it normally is considered more economical to operate one central warehouse provided certain conditions exist. These include:

A. Reasonable distances from central warehouse to mines to keep down delivery time.

B. Good highways and good trucking facilities to permit fast deliveries.

Where these conditions exist, central warehousing, as noted, is considered feasible and economical, except for certain types of supplies, such as, timber, rail and the like. Of course, a certain volume of other parts and supplies must be kept at each mine and, in fact, at each deep-mine or pit face, to facilitate maintenance and prevent operating delays arising out of such things as lack of timber, etc.

4. Cooperative stocking. Where a part or a component is large and costly and requires considerable time to repair or, if completely wrecked, must be manufactured from scratch, it is possible for a group of companies in an area to buy one such component or part and rotate it around as needed.

5. Independent warehousing. Where manufacturers, their agents and independent supply houses have branch or main establishments close to the coal fields, maintain stocks of the desired items and provide quick delivery, it is possible to use them as the source for many items, thus cutting down on both inventory and on company-owned warehousing facilities.

6. Price trends. If one is willing to risk the hazards of estimating future trends, it may turn out to be desirable to run up the inventory of parts and supplies—at least in part—to offset expected price increases, or to curtail purchases in anticipation of decreases.

Storage and Handling

TYPE, SIZE AND COST of specific items normally dictate methods for receipt, storage and issuance. Thus, depending upon these factors, both enclosed and open storage are employed at mines. Enclosed or covered storage includes both regular supply

buildings and also sheds for certain items requiring less protection.

Open or yard storage is satisfactory for timber, steel ties, rail and the like including heavy equipment items that are not appreciably affected by rust and other deterioration as a result of exposure to rain, snow, dust and the like. Where the items are made, for example, from copper and lend themselves to theft, enclosed storage normally is dictated to prevent losses of this type. Shed storage may be desirable for pipe structural shapes, plate and the like to pevent excessive rusting and also avoid difficulties with snow and rain in storing and handling. However, shed storage rules out, in most instances, the use of mobile cranes in handling such items, and the ability to use such equipment may outweigh the disadvantages of open storage.

Storage Layout

While the storage layout will vary from mine to mine, the plan shown in the accompanying diagram illustrates some of the basic principles involved in achieving efficiency, convenience and protection. In this instance, the shop is near the supply house and thus a separate shop supply is not required.

Supply-House Facilities

Supply houses include both bin storage for small or moderate-sized items, and floor storage for heavier units. The floor-storage facilities at one new supply house include a basement for cool storage of rubber-covered cable, conveyor belts and other rubber items. Access to the basement is by 25-ton hydraulic lift, large enough to handle even the heaviest reels of cable and belt, which can be rolled on and off.

Some supply houses include a monorail and hoist for handling heavy units into and out of the floor-storage area, and storage facilities for such heavy items, include, in addition to open floor, racks for, say, spare armatures.

Other facilities which have proved successful in simplifying the handling of supplies in warehouses include: sectional steel bins with adjustable shelves; drawertype and rotating bins for small items; clear plastic chest and drawer units for miniature units; shafts and reels mounted on walls or stanchions for convenience in paying out and measuring cable, hose, rope, etc.; peg racks for V-belts and similar items; and platform-top push trucks for moving items to and from bins, especially if the warehouse occupies a rather large floor space.

If bins are built up higher than eye-sight level or arm's reach, trolley or wheeled ladders or steps save time and reduce the possibility of injury. One wheeled step, for example, includes springs which gives when a man puts his weight on the steps and thus provides solid footing.

Light should be ample to read tags, nameplates and the like, and the sources should be placed so that it is relatively easy to see into the backs of shelves or bins, especially those high up.

Other ideas employed to facilitate storage and handling include: Easy access to bins, for safe and quick disbursement of parts by the use of permanent stairways and balconies. Monorails equipped with hoists and armature racks mounted on wheels (see illustration) save space and facilitate handling of heavy parts.

Allocation of Stocks

THE CARDINAL PRINCIPLES of stock allocation are: (1) make studies to determine type and quantities of parts and material necessary to keep production interruptions to a minimum, and (2) provide such supplies at or near the point of use.

Stocks of frequently used machine parts, for example, should be kept close to or in the pit or underground section for the use of the section or pit electrician or mechanic.

EQUIPMENT REQUIREMENTS—Once essential repair parts have been supplied, replacements for such stocks normally are charged to operating cost when they leave the main supply house. If it is desired, as discussed previously, to keep accurate use records, the section or pit electrician or mechanic can file reports showing use of items by machine number, thus enabling operating management to keep track of where parts and materials go. Rather than a separate report, the section mechanic's or electrician's daily delay and repair report can show what items are used and where.

CENTRAL WAREHOUSING SYSTEM—Where two or more mines are involved and the central warehousing system is employed, allocation might be along the following lines:

1. Principal stock of repair parts at the central warehouse.
2. Subsidiary stocks at the central repair shop, provided it is not adjacent to the central warehouse.
3. Subsidiary stocks at the mine shops.
4. Section stocks in the working sections or pits for running repairs and maintenance.
5. Stocks of ties, timbers, roof bolts and similar items at the individual mines, since it is more convenient and less costly to have such materials delivered directly to the mines for storage and distribution rather than rehandling them from a central point. In fact, even where only one mine is involved, it may be more convenient to provide separate facilities for receiving, storing and distributing (a) machine parts and smaller items, and (b) larger, bulkier items used every day the mine runs.

Special Supply Houses

POWDER MAGAZINES, oil houses, sand-storage and drying facilities, and even portable or semi-portable pit or mine houses are considered as special supply facilities.

POWDER MAGAZINE—Design and location of this storage facility is a matter of following the recommendations of state and federal safety authorities and the Institute of Makers of Explosives.

OIL HOUSES—There is good reason for putting oil houses and oil-storage facilities apart from other surface units. However, there is no reason why they cannot be located for easy receipt of supplies either by truck or rail. As a matter of fact, convenient, clean and safe facilities for dispensing are as much factors in oil-house design as storage.

Designs most nearly meeting these objectives include: steel and concrete construction, racks that hold drums in proper position for dispensing, hoists or other mechanical facilities for handling drums, and provisions for catching drip and spillage. Fixed racks should be provided with inclined ramprails to permit rolling drums up to position, unless chain hoists are used. Chain hoists, incidentally, make it easier to replace drums without handling of others, as do tilting-type racks with casters, which may be pulled out of position, run to the storage area and tilted to permit taking off the drum, after which the process is reversed to put a new drum into position.

An example of a well planned oil house is shown in the accompanying illustration (Texas Co., "Lubrication of Coal-Mine Machinery"). Note that oil drums are delivered on a platform at truck-bed level. After drums are emptied they are rolled to the end and under the top rack to the outside.

SAND HOUSES—Terrain and other considerations affect sand-house design and location. If possible, the facilities should include storage for a specified number of truck loads. In hilly country, where sand is received by truck particularly, it may be possible to build the road up on the hillside so that trucks can dump directly into the bin.

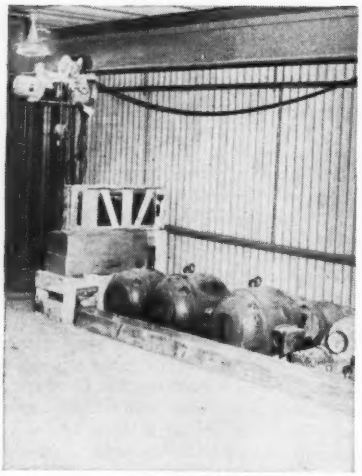
The preceding comments presuppose gravity flow from the wet storage bin to the drying stove or stoves, and from the stoves or dry-sand bins to the locomotives, sand cars or bore-hole to the mine-bottom. This gravity flow materially reduces labor in all phases of receiving, drying and dispensing sand, and this saving may warrant a substantial investment in bins and gravity-handling facilities which, in some instances, are almost or completely automatic.

Though not yet possible in too many mining areas, sand-handling facilities may be eliminated completely by depending upon outside suppliers for drying and delivery. At one operation, the custom drier delivers the sand in oil-type drums ready for movement into the mine.

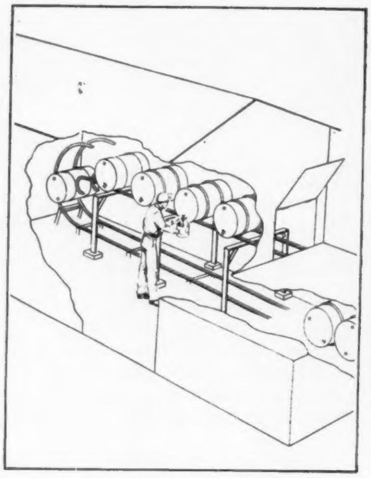
PORTABLE SUPPLY HOUSES—Under certain circumstances, a "portable" supply house becomes quite convenient in addition to providing protection and promoting order in dispensing supplies—particularly machine parts. One circumstance is stripping where frequent moves are made from one location to another. Another is deep mining of the contour type, where the main opening keeps moving around the hill. Under such circumstances, a number of mining companies have bought small prefabricated buildings and mounted them on skids or trucks for towing from one location to another.

Supply Delivery

SURFACE AND UNDERGROUND DELIVERY is the last operation of a supply



STORAGE AREA for medium-sized motors is served by a hoist and monorail.



TYPICAL LAYOUT of an oil storage house permits easy handling of oil drums.

24-INCH BOREHOLE cuts time in getting small parts underground.

control system. The methods and the equipment employed to deliver supplies are determined by local conditions and the overall supply setup.

Delivery Schedules

Delivery between supply house and shop where the two are not too far apart and are connected by a hard-surfaced roadway may be handled by hand-pushed lift cranes, motorized cranes or special motorized flat-bed trucks.

Supplies delivered from a central supply house to one or more mines usually are handled by motor trucks. It is important that order and delivery schedules be worked out. Requisitions from the various mines, for example, should arrive at the supply house at a designated time to permit the supply clerk to fill the orders before the supply crew is due to arrive.

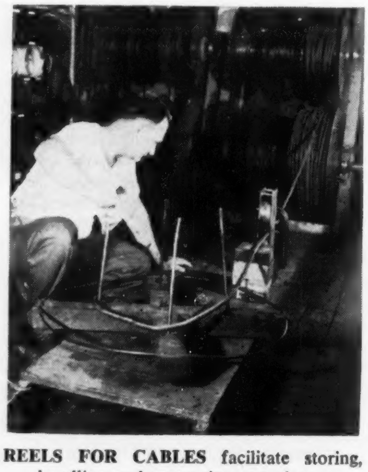
Surface Delivery

The motor truck in its regular form is the work horse in supply and delivery on the surface. In its special forms, especially at stripping operations, it includes grease trucks—usually designed for actual application of the grease at the point of use as well—fuel trucks and utility trucks. And at some operations, the final stage in storage and delivery of explosives—at strip mines, for example—is handled by small rubber-tired units designed for towing on the bank by tractor, relieving the regular truck for other duties.

Underground Delivery

Where mine cars are employed to haul coal, the same track is used for delivery of supplies—perhaps to the face or, if trackless mining is the rule, to the point where the rails end. Even with belt haulage, convenience in handling supplies and men has led a number of operators to put supply tracks alongside the belt conveyor—or in a parallel heading. Battery locomotives may be equipped for pulling the equipment on such auxiliary track systems to avoid having

MOBILE CRANE with attachments handles heavy materials in the supply yard.



REELS FOR CABLES facilitate storing, handling and measuring out pieces.

to put up trolley wire. And in some instances, rubber-tired tractors and trailers are employed to take in supplies, eliminating track completely. With either system, the added convenience and saving in time and labor is held to warrant the installation of the track or the preparation of the special roadway for the trackless battery units.

Where belts are installed for haulage, especially single panel units, they may be provided with reversing facilities for movement of supplies back to the face. In some instances, at least, special inching and jogging controls have been provided to facilitate handling long cross-bars and other items without hazard to men or to the belt and conveyor.

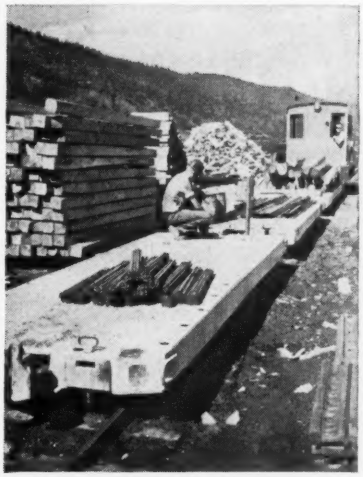
Facilities for delivering supplies to the faces of rooms equipped with conveyors include:

1. Dolly trucks running in shaker lines.
2. False pan lines, or lines of pans alongside the operating line, which are loaded with supplies and pulled up as the main line is extended, the face pan going into the operating line and the supplies to other face operations. At the same time, a new pan is added at the outby end and loaded with supplies until the place is halfway up, at which point the loaded line will complete the place.

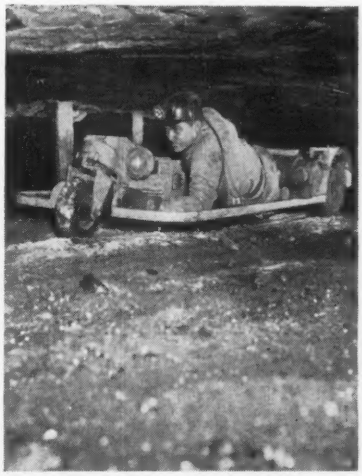
In pitching places small hoists may be included in the equipment at the face to pull timber and other materials up from the track on the gangway below.

MOBILE UNITS—For the most part, unless pitch or some other condition prohibits, the mobile unit operating either on or off the track is the most efficient and flexible unit for supply delivery. In trackless areas, the mobile unit may be a shuttle car, though using a shuttle car on the working shift may result in interference with production. If supplies are delivered on the off-shift, the shuttle car may well double in brass. And if crawler trucks are used for moving shortwalls, these same trucks may also be employed for handling heavy units, such as motors, drives and the like. Special crawler-mounted pullers and carriers also have been built for moving drives and handling materials.

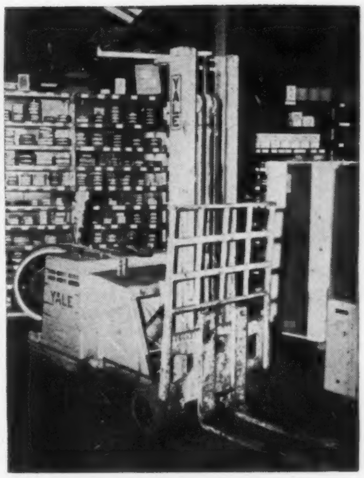
The extra advantages of special equip-



VERSATILE FLAT-BED TRUCKS facilitate supply delivery to working sections.



SUPPLY CAR EASES HANDLING of parts and supplies in thin seams.



PORTABLE LIFT handles supply and equipment in shop and supply house.

ment, including availability at all times, design for handling materials and the like, have led, among other things, to a substantial growth in such equipment as battery powered tractor-trailer units, especially in trackless areas. Some mines also have used the equivalent of a straight truck with a battery for power.

For trail delivery, the mine car, as noted, still is the mainstay. However, special cars and trucks provide a number of advantages, including better design for loading, unloading and protection of materials and supplies. An example is the low-height flat-bed car with steel deck and holes all around for stakes which lends itself to handling almost any shape or size or material or part. Such cars are used on moderate-pitch slopes as well as on the flat. In tandem and properly loaded, such cars also can move rails and long timbers, though the special rail truck still is a standard item at most operations.

Other special cars which a number of operations have found advantageous include the following:

1. A utility car with a cab for the snapper equipped with plastic windows, and compartments for such items as steel ties, miscellaneous track and trolley supplies, coal augers, roof bolts and the like.

2. Sand cars especially designed for the service, including sides low enough for easy unloading to sand boxes.

3. Enclosed powder cars with sliding doors and insulated couplers.

4. Special insulated detonator cars with steel doors, wood and rubber lining and compartmented drawers.

5. Special ballast cars with bottom doors designed for spreading ballast in the track.

Special handling facilities at unloading or transfer stations underground can materially speed up the job and reduce the hazards. Oil drums, for example, may be lifted off trucks or out of cars by a small chain hoist and run back into the underground depot on a monorail. Similar facilities also may be installed for handling timber, roof bolts and other bulky, lengthy or heavy materials and parts. Handling is facilitated by bundling or tying the materials, such as, timbers, to make it easier to hook onto them with the hoist. In fact, some companies ask that lumber and certain other materials be bundled and strapped by the supplier to facilitate handling all along the line. Properly designed, underground stations of this type make it easy to unload and store materials until the face equipment is ready, then facilitate reloading for distribution.

Preventing Waste and Loss

IN VIEW OF THE COST of materials and supplies these days a carefully considered salvage program can result in major savings. Waste and loss, if not controlled, can play havoc with the supply budget. The operating department can contribute greatly to reducing waste and loss.

Key Factors

There is no particularly easy road to reducing waste and loss in parts and materials, but results can be achieved by, among others, the following methods:

1. Good Records—Where supplies go and how much (see "Records and Reports").

2. Education—Some companies have found for example, that a display of certain supply items, each tagged with its cost and accompanied by some pertinent words by the superintendent or foreman, brings home to men the costs involved in loss or carelessness and consequently leads employees to handle materials and parts more carefully.

3. Prevention of Machine Abuse—This is largely a matter of training both operators and supervisors in how abuse results in breakdowns, lost time and an increased cost for parts.

4. Rated Voltage—Along with education of operators and supervisors, the rule should be rated voltage at the terminals of all machines, since less than rated voltage inevitably results in an increase in machine breakdowns, with attendant loss of time and increase in parts consumption.

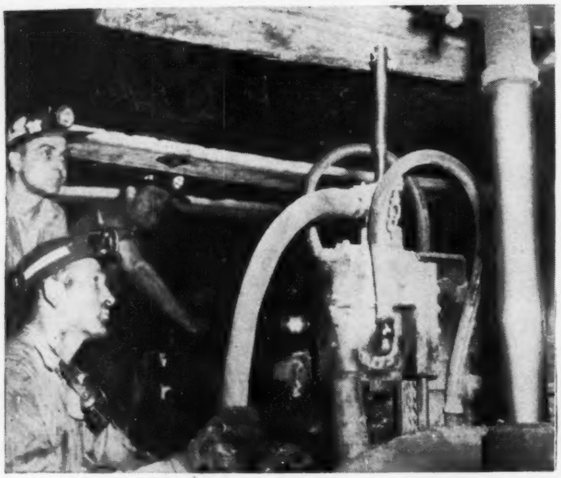
5. Protection—Moisture in cement, coal dust in an open container of oil, and a bundle of roof bolts thrown along the rib and covered with loose coal are all examples of loss through failure to protect materials and supplies. The moral is enclosed storage for materials or parts subject to weather or water damage, enclosed containers for lubricants all along the line from receipt to point of use, and specific places for everything in the supply line—for example, special supply delivery points, with cabinets, chests and the like as necessary in every section for receiving and storing parts and materials. Indiscriminate dumping inevitably results in loss.

Salvage

The extent of salvage operations depends upon the value of the part or item in relation to the cost of getting it out and, if necessary, reconditioning it. Expending $2 on labor to recover something worth only $1 in the first place is, of course, out of the question.

Education is a major ingredient in an effective salvage operation. In other words, if men are encouraged to form the habit of picking up anything they see lying around and turning it in to a specific salvage station—on each section, for example—rather than walking by or, even worse, pitching things into the gob without thinking, the company benfits not only by return of usable parts and materials but also from the scrap value of worn out items. Of course, each foreman should check on loose and misplaced materials constantly.

Certain items lend themselves to the use of organized salvage crews—for example, crossbar and post recovery. Equipped with mobile pulling units involving wire lines, chains, slings and winches, such crews can, where safety considerations permit, recover several times their wages in posts and bars —as well as ties, rails and so on. A few mines have even used mine-detector-type equipment to find carbon-dioxide coal-breaking shells, steel ties and like buried in loose coal or gob in working places.



TOP-FLIGHT EQUIPMENT, with all safety-serving auxiliaries attached and operable, well-trained men and good housekeeping throughout the property are basic ingredients of an effective safety program. Knowledgeable top management provides these ingredients.

Fundamentals in Safety

Since 1955

Development of remote-control systems for withdrawing machines from difficult situations; refinement of bulk-handling and application methods for rock dust, and research leading to the commercial availability of fire-resistant hydraulic fluids were highlights.

Ahead to 1965

Redoubled emphasis on reducing the rate of mine fatalities per million man-hr of exposure.

Full refinement of self-advancing roof shields for face areas.

MAXIMUM SAFETY and high efficiency are inseparable hallmarks of good coal mining. Efficiency follows where safety is stressed, but neither safety nor efficiency prevail where this emphasis is lacking. The safety impetus must come from truly-professional management, sincerely backing the program from the top levels. The beneficial results will be (1) increased well-being for the industry's employees, (2) increased stature for the industry in the eyes of the public, (3) immediate reductions in cost through lower compensation premiums and other direct savings, (4) improved industrial relations and (5) lower labor turnover.

Safety, like other matters of concern to management, lends itself to a planned approach. The steps in planning are as follows:

1. Organize for safety, employing all available skills to the fullest degree and enlisting all interested parties.
2. Train and educate for safety, using planned programs for workmen, supervisors and management.
3. Maintain the physical features of the mine and its surroundings in the approved manner to eliminate conditions leading to accidents.
4. Keep interest alive by a continuous program of safety incentives, any of which may be scrapped without remorse the minute it loses its appeal.

Organizing for Safety

THE TYPE OF ORGANIZATION depends upon the job to be done. Within the company there are a number of functions to be performed. Someone must head up the program, someone must inspect the workings, the ventilation system must be patrolled, training must be conducted, and so on. If the company is small all these responsibilities may be handled by one man. In larger companies operating a number of deep and strip mines and cleaning plants the safety department may include one or more qualified men to fulfill each of the functions that must be served.

PROPER STAFF—The important requirement is that some provision be made for handling each function, and this is another top-management exercise in bringing together the skills available within the official family and the jobs to be done. The staff of the company safety department should be neither too large nor too small. An overweighted safety department may become a "dumping ground" for a number of other activities for which a natural home cannot be found in other company departments. The result is a loss of enthusiasm for safety and these losses are doubly difficult to make up.

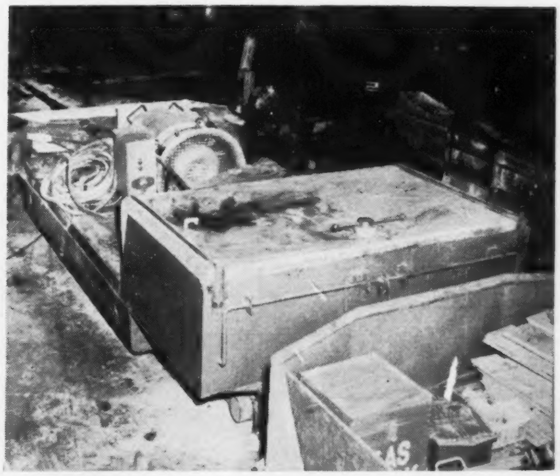
The understaffed safety department, on the other hand, may miss too many good bets in safety because of difficulty in maintaining proper coverage of its legitimate responsibilities. The best way to get the proper manpower, in quantity and quality, is through sincere top-management consideration.

EMPLOYEE PARTICIPATION — Employee safety committees should be included in the table of organization. Their recommendations concerning hazards should be heeded and acted upon, their suggestions should be carefully weighed, and their active support in training and promotion ventures should be solicited at the beginning.

JOINT ACTION—Wholehearted support of local safety associations and institutes by the company and participation of company safety officials in the affairs of Holmes councils and chapters, the National Mine Rescue Association and National Safety Council, for example, are proper extensions of top-management's interest in safety. These, too, represent organization for safety. Of course, cooperation with federal and state safety and inspection authorities is an integral part of any safety effort.

Training and Education

Safety education is a broad program designed to convince workmen and supervisors



SAFETY IS ENHANCED through the use of modern units like the high-capacity rockduster (left) and the firecar, equipped with foam generator (right). Emergency equipment should be tested periodically and carefully maintained.

of the waste inherent in a high accident rate, and of the real values in high safety performance. Safety training, on the other hand, usually takes the form of a hard-hitting, direct attack on particular hazards. Safety education is a continuous process, while safety training, on any particular subject, begins, proceeds and concludes in a scheduled well-planned manner.

The educational mission can be carried out through the use of a company publication (if thoughtfully prepared), a well-planned poster campaign, word-of-mouth advice and management example. The safety display board near the lamphouse or at the entrance to the property can be a big help here. If it can't be kept timely, however, and if it isn't kept reasonably clean and in good repair, it might better be removed from sight.

ONE objective in advanced training is the development of new instructors who will spread their influence among the working force.

TRAINING FUNDAMENTALS—A need for training is indicated by a general rise in frequency or severity rates. Or the number of injuries chargeable to a single cause—haulage, for example—may spurt upward. Next step is to select the training material, basing the selection upon the recognized needs of those to be trained. If an outside agency is to conduct the training, these instructors and company representatives should meet to examine the content of the course to make certain it fills local needs.

Course material should be severely limited to the interests and needs of the trainees. In a course for cleaning-plant personnel, very little reference need be made to the fact that roof falls and haulage are the major causes of accidents in the industry. They are more concerned with safety on stairs and ladders, and with such other matters as falls of person, open machinery, dust hazards and electric shock.

PROMOTING ATTENDANCE — The problem of getting men to attend the training sessions can be a tough one. The safety committee can be of great help here, if the committee has been consulted early in the planning stages. In striving for 100% attendance at accident-prevention training sessions conducted by Bureau of Mines instructors, company officials will achieve maximum results by working closely with district officials.

Beyond this basic training area there is advanced training work any company may profitably pursue. Periodic training in advanced first aid and mine rescue may be offered to selected men and supervisors. One important goal of this training should be the development of new instructors.

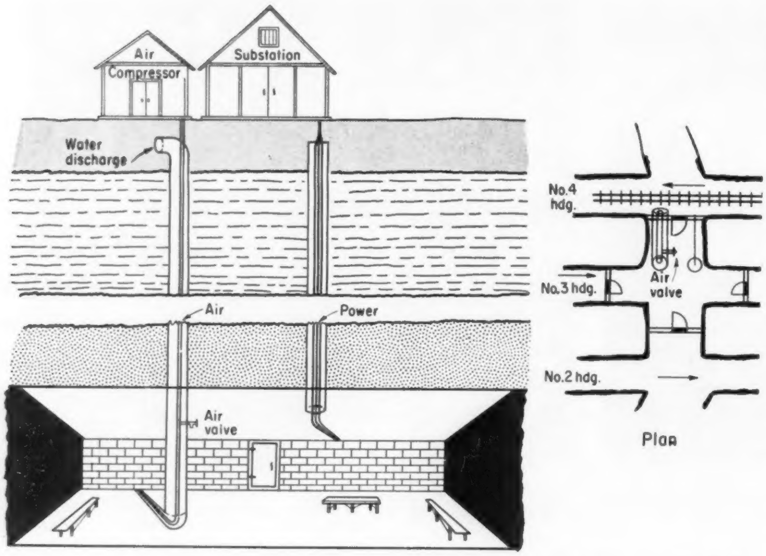
Training, though, is not an end in itself. The clincher is in management's follow-through, which insures that results match the effort.

Maintaining the Plant For Safety Benefits

VIGILANCE is the keyword in maintaining a mine, cleaning plant or strip pit in safe condition. A sluggish track switch in the mine, "soft" brakes on a strip-mine haulage truck, dust accumulations in the preparation plant—all these are examples of potential accidents that can be headed off by good plant maintenance. In this connection, the plant includes all real estate, above and below, and equipment.

The steps through which this safety maintenance is achieved are the old standbys—inspection, reporting, repairing and following through. It is to be noted here that all technical and operating departments have a safety function, inasmuch as each is responsible for some degree of inspection and repairing within its own area.

Many companies, employing full-time safety inspectors, have set up hard-and-fast rules on clearing up hazardous conditions. The company safety inspector at the end of his visit leaves at the mine or plant a list of the hazards and violations of good practice he has found. Copies of this list are filed in the safety department and with the operations chief. Mine officials are required to take appropriate action to remedy the condition, then report their actions through proper channels to the chief of operations. If such a report does not come up within a specified time, the safety department and chief of operations begin to ask questions. The system insures follow-through on safety-department recommendations for improvements in practices.



PLANNING FOR EMERGENCIES could include the development of emergency havens like this permanent barricade in an unused substation.

Deep Mines

The most important elements in maintaining a deep mine in safe condition are roof support, methane control and dust suppression. Falls of roof, rib and face still are the No. 1 killer, although a striking improvement under bolted roof is now in the records. The most promising remedies are closer supervision, strict compliance with timbering standards and bolting patterns, including as much extra support beyond the standard pattern as necessary, and better trimming of overhanging brows and loose coal. These are the only possible solutions to the problem as long as men are needed at the face.

A new development, for increased safety in the immediate face area, is a self-advancing roof shield which may be powered from the hydraulic circuits of a continuous miner.

Efficient ventilation is safe ventilation. Proper methane control demands that sufficient air at reasonable velocity be moved past active faces to dilute and sweep away the gases issuing from the coal. Maintenance of physical plant in the interest of safety demands that bleeders, if they are part of the mining plan, be kept open, that stoppings be sealed against leakage and that airway obstructions be removed. Effective gas detectors also must be considered as safety maintenance tools.

In underground dust suppression the big guns are rock dust and water sprays. The latter may include wetting agents. Recent developments in rock-dusting machinery now permit in-cycle distribution. And the latest development is the application of the air-slide principle to rock-dust handling and application underground. Efficiency is remarkably increased, and labor requirements are reduced.

The goals in rockdusting are (1) proper distribution to meet requirements for incombustible content and (2) achieve the first goal without creating a visibility problem with airborne rock dust. The latter becomes acute when dusting in-cycle behind a continuous miner. Now in use is a slurry-type rockduster which can be mounted directly on mining machines, and a self-propelled unit.

Whatever the methods, however, the main point is that the rock dust should be evenly distributed, in back headings and returns as well as in more active places, and on roof an ribs as well as floor. Rock-dust barriers may be included in the overall plan, and the importance of loading out excessive accumulations of coal dust should not be overlooked.

In all instances, maintenance of a safe plant requires the establishment of fire-fighting systems, including water lines, tested fire-hoses and chemical extinguishers, where needed. There is great value also in developing efficient fire-fighting organizations with assigned duties for key people. One company has conducted underground fire drills, using smoke bombs to focus the situation in order to train workmen in the actions they should take.

New developments should be given full consideration in fire-prevention and fire-fighting programs. One manufacturer reportedly offers a dry, bagged material which is effective against all classes of fires. The chemical is capable of producing carbon dioxide in the presence of fire and does not deteriorate upon standing. Also important is the foam-plug method of fighting fires.

STRIPPING—In stripping, safety maintenance is primarily a matter of equipment maintenance. A schedule for wirerope changes should be worked out, since each unexpected rope failure is a potential accident. Haulage trucks must be kept in good condition to head off steering and brake failures particularly. Well drained smooth-surfaced roads may eliminate dangerous skids, and in dry weather road surfaces should be sprinkled to allay dust.

Truck spotters must be properly trained to stay out of the way of backing trucks and out of close clearances around dump ramps. They should also be competent in keeping drivers out of trouble.

PREPARATION—In preparation plants, particular check points for safety inspectors are dust accumulations on beams, housekeeping in the oil-storage area, cleanup precautions before any welding is done, open gearing, exposed wiring, overhead obstructions and so on.

The possibility of using paints of different colors in the plant might be weighed. For example, standard colors for safety include red for fire exit signs and fire equipment; orange on the inside of movable machinery guards and exposed edges of pulleys, gears, rollers and so on; yellow for handrails, top and bottom steps and caution signs; green for first-aid equipment; and black and white for traffic lanes and direction signs.

One final requirement if all this maintenance is to be meaningful, is that workmen wear proper articles of protective clothing and refrain from wearing loose clothing.

Keeping Interest Alive

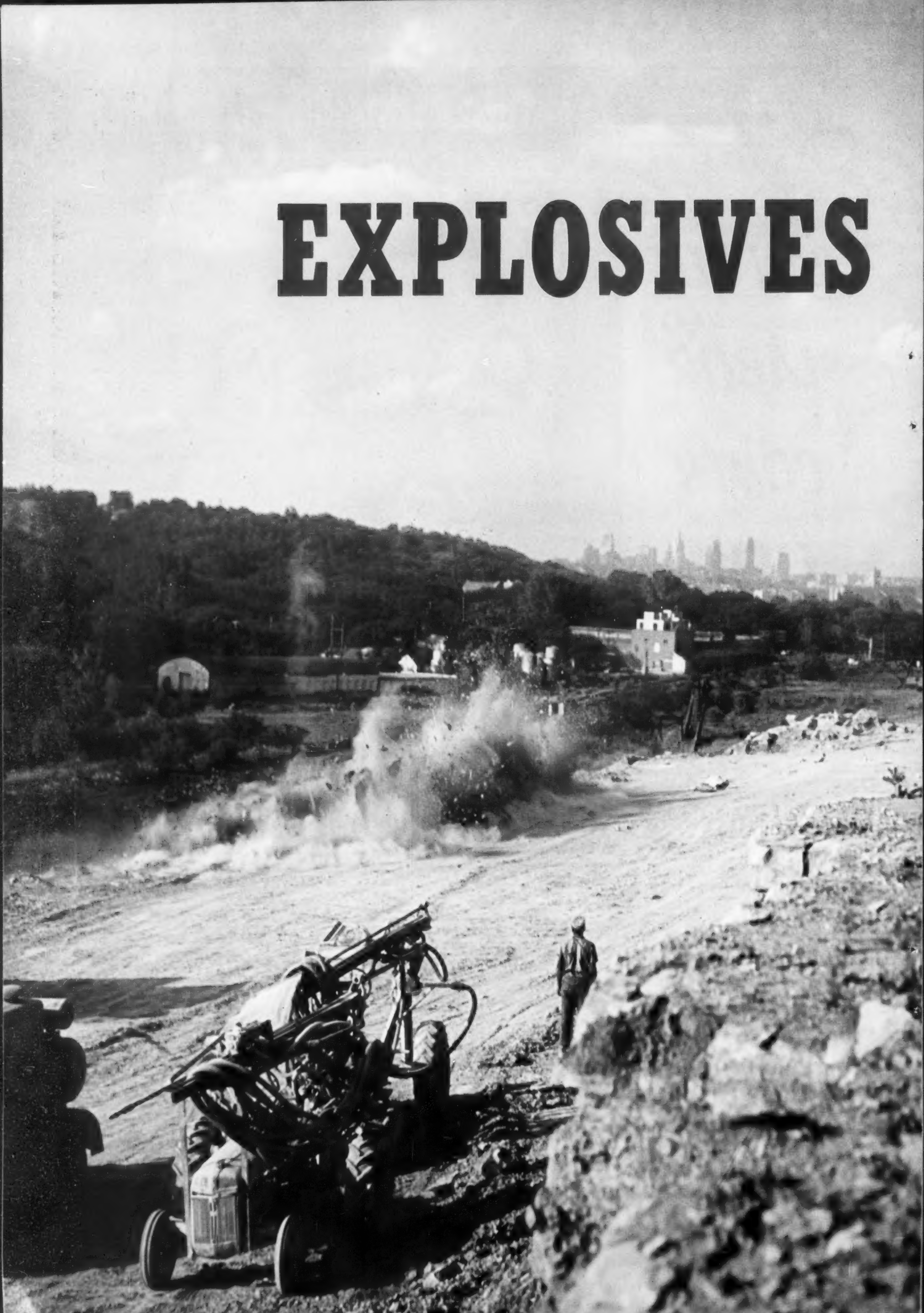
ILL-ADVISED INCENTIVES may not set back the cause of safety but they can be a waste of time for the safety department. A decision to adopt or reject a proposed incentive must be based upon thorough study, with local conditions and personalities weighing heavily in the final judging.

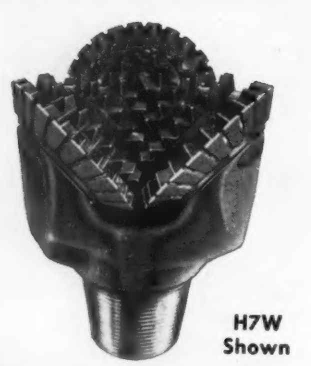
Strange as it may seem, safety bonuses for supervisors have not been an unqualified success in all quarters. The privilege of wearing a white safety hat for supervising a crew through an accident-free month may be more exciting. And even more worthwhile is some scheme where everyone participates in making a good record and shares in the acclaim.

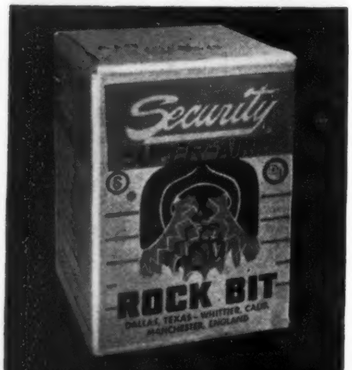
Slogan contests are effective attention getters, if properly conducted. Application blanks may be distributed as payroll inserts. The response will be gratifying if the prize is worthwhile. Then interest and participation in the next contest will be assured if the winning slogan is widely promoted.

Once an incentive has been adopted it must be given a fair chance to succeed. But if it still fails to have the desired effect in creating enthusiasm or reducing injury rates, it must be summarily discarded. Permitting such an incentive to drag on with only half-hearted promotion may be mighty damaging to the entire safety program. Best practice in a situation like this is to have another idea ready to take the place of the incentive you must scrap, although the new idea should be one that has a better-than-even chance of success.

FOLLOW-UP TRAINING—Timely scheduling of refresher training sessions is another way of keeping safety interest at a high level. The accident-prevention training offered by the Bureau of Mines is practically a "must" at all mines because it has captured the interest of the men at mines where it has been given already. Follow-up sessions on this type of training are especially recommended to insure that maximum longtime benefits accrue.


EXPLOSIVES





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S SERIES — For Soft Formations* Designed to effectively drill the complete range of softer formations... shales, soft sandstone, soft limestone. Maximum offset of cones for greatest twisting — tearing action and long teeth assure fastest penetration rates. Self-cleaning action of cutter designs and placement of air courses prevent balling up and permit rapid removal of loose particles from bottom of hole.

M SERIES — For Medium Formations* General purpose bits for fast drilling of medium hard limestone, shaley limestone and other medium formations. Moderate offset is employed to increase penetration rates. Additional gage protection is provided by "T" tooth designs where formations are abrasive. Special cutter features, combined with sturdy tooth design, of these versatile bits, offer greater strength to withstand heavier drilling weights in harder formations.

H SERIES — For Hard Formations* Especially designed for use in harder formations, such as dolomite, hard limestone, traprock. Sturdy teeth, closely spaced on extremely strong cones, are capable of withstanding heaviest drilling weights. Gage tooth configurations are available with "L", "T" and full webb sections for hardest and most abrasive formations that can be cut with steel toothed bits. True rolling, non-offset cutters and extra large bearings assure longest life.

VARIABLE SIZE JETS AND AIR COURSES — To obtain optimum drilling performance, "Super-Aire" bits have field replaceable jet air nozzles or variable size air courses. Maximum cooling effect and optimum bottom hole cleaning can be obtained by selecting the proper size openings to suit the volume and pressure of the air available on the job.

UNRESTRICTED AIR PASSAGES—"Super-Aire" bits have unrestricted air passages to the bearings — an exclusive Security feature. The size of the passage is not limited by the ball retaining plug as in other bits. This permits proper air metering to critical areas, thus achieving maximum air expansion for most effective cooling.

SELF-CLEANING SCREENS—Security's exclusive extra-large capacity, full-length, self-cleaning screens minimize the possibility of plugged air passages which could result in rapid destruction of the bearings. Self-cleaning screens combined with unrestricted air passages assure superior performance of Security "Super-Aire" blast hole bits under the most severe operating conditions.

SHIRT TAIL HARDFACING — Shirt tail hardfacing is furnished on all "Super-Aire" bits in sizes $7\frac{3}{8}$" and larger.

**Jet air or regular air types available. Send for Catalog.*

Security®

ENGINEERING DIVISION
P. O. BOX 13647
DALLAS, TEXAS

DRESSER
INDUSTRIES,
INC.

The Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

EQUIPMENT, MATERIALS AND SERVICES FOR COAL MINING, together with the names of those who furnish them, are shown in Part 1 of this Buying Directory, starting on this page.

All products, materials and services, with their suppliers in each instance, are listed alphabetically under the key words. For example, look for "Bearing, Roller," rather than "Roller Bearings." If a product does not appear under one possible classification —for example, "Cable, Welding"—look for the alternative listing—in this instance, "Welding Cable."

BLACK-FACED TYPE indicates a manufacturer or supplier providing more detailed data on available equipment, materials and services through product-information advertisements in this issue (see p 380 for Advertising Index).

THE ADDRESSES of the manufacturers, suppliers and service organizations appearing in the Buying Directory are listed under the company names in the Directory of Manufacturers beginning on p 357 of this issue. For added convenience in obtaining equipment, services and materials offered by advertisers in this issue, their sales offices and representatives are shown in the Advertising Index beginning on p 362.

ABRASIVES, DIAMOND INDUSTRIAL
Metallurgical Products Dept., General Electric Co.

ACETYLENE GENERATORS
Air Reduction Sales Co., Div. of Air Reduction Co., Inc.
Rexarc, Inc.—"SIGHT FEED"

ACTUATORS, CYLINDER, LINE VALVES
Ledeen, Inc.

ADDITIVES, FUEL OIL
Warren Refining & Chemical Co. —"PVR"

ADDITIVES, LUBRICANT
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Shell Oil Co.
Stewart-Warner Corp., Alemite Div.
Warren Refining & Chemical Co. &"PVR"

ADHESIVES
Automatic Vulcanizers Corp. (self-vulcanizing solutions)
B. F. Goodrich Industrial Products Co.—"PLASTILOCK," "VULCALOCK," "DUOLOCK"

AERATORS, BIN
The Bin-Dicator Co.—"BIN-FLO'

AERIAL SURVEYING, MAPPING
Aerial Surveys, Inc.
American Air Surveys, Inc.
Jack Ammann, Inc. Engineers & Surveyors
Fairchild Aerial Surveys

AERIAL TRAMWAYS
Interstate Equipment Corp.
Kurt Orban Co., Inc., Industrial Equipment Div.

AFTERCOOLERS, AIR
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Worthington Corp.

AGITATOR CONDITIONERS
The Daniels Co.
Eimco Corp.
WEMCO Div., Western Machinery Co.—"WEMCO"

AGGREGATE PLANTS
McDowell Co. Inc.—"DWIGHT-LLOYD®"

AIR CLEANERS, COAL
Link Belt Co., Dept. CAMGL—61
Ridge Equipment Co.—"RIDGE-AIRJIG"
Roberts & Shaefer Company, Division of Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"

AIR COMPRESSORS, PORTABLE, MINE
Acme Machinery Co.
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.—"MINEAIR"
Long-Airdox Co.—"AIRDOX"
Morse Bros. Machinery Co.

AIR COMPRESSORS, PORTABLE, SURFACE
Chicago Pneumatic Tool Co.
Davey Compressor Co.—"SUPER CHIEF," "AIR CHIEF," "PERMA-VANE"
The Galigher Co.—"QUIKAIR"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.—"GYRO FLO"
Joy Mfg. Co.—"AIRVANE"
Le Roi Div., Westinghouse Air Brake Co.
Lincoln Engineering Co., Div. of McNeil Mach. & Engrg. Co.
Long-Airdox Co.—"AIRDOX"
Morse Bros. Machinery Co.
Schramm, Inc.—"PNEUMA-POWER," "UNISTAGE," "PNEUMADIESEL"
Worthington Corp.

AIR COMPRESSORS, SELF-PROPELLED
Acme Machinery Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Schramm, Inc. — "PNEUMA-TRACTOR"

AIR COMPRESSORS, STATIONARY
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co.—"INDUSTRIAL AIR"
Le Roi Div., Westinghouse Air Brake Co.
Lincoln Engineering Co., Div. of McNeil Machy. & Engrg. Co.
Long-Airdox Co.—"AIRDOX"
Morse Bros. Machinery Co.
Nash Engr. Co.
Ore Reclamation Co.
Pennsylvania Pump & Compressor Co.
Schramm, Inc.—"UNISTAGE"
Schroeder Brothers Corp.
Stewart-Warner Corp., Alemite Div.
Worthington Corp.

AIR-LINE FILTERS
Aro Equipment Corp.
Hunt Valve Co.

AIR-LINE OILERS & SEPARATORS
Acme Machinery Co.
Aro Equipment Corp.
The Branford Co.—"BRANFORD"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Hunt Valve Co.—"QUICKAS-WINK"
Ingersoll-Rand Co.—"OIL-IR"
Joy Mfg. Co.
Schroeder Bros. Corp.
Stewart-Warner Corp., Alemite Div.—"TRI-DUTY"
Thor Power Tool Co.

AIR RECEIVERS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Koven Fabricators, Inc.
Pennsylvania Pump & Compressor Co.
Worthington Corp.

AIR SEPARATORS, MECHANICAL
—See "Cyclones, air treatment"

AIR SUSPENSIONS
Clark Equipment Co.,—"CLARK-AIR"

ALARMS, BEARING-TEMPERATURE
The Bristol Co.—"BRISTOL'S"
Foxboro Co.
West Instrument Corp.

ALARMS, TRACTOR, TRUCK BACKUP
E. D. Bullard Co.

ALIDADES, PLANETABLE
Kern Instruments, Inc.

ALLOYS
Crucible Steel Co. of America—"HYTUF,"® "MAXEL"®

ALLOYS, NICKEL
Huntington Alloy Products Div., International Nickel Co., Inc.

ALTIMETERS
American Paulin System—"MICRO," "TERRA"

ALUMINUM
Aluminum Co. of America
Reynolds Metals Co.
Joseph T. Ryerson & Son, Inc.

ALUMINUM WIRE, ROD & BAR
Aluminum Co. of America

AMMETERS, CLAMP-ON
General Electric Co., Apparatus Sales Div.
Martindale Electric Co.

AMMETERS, INDICATING
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMETERS, RECORDING
The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

AMMONIUM-NITRATE BLASTING AGENTS
Airmite-Midwest, Inc.
Propellex Chemical Div., Chromalloy Corp.—"PROPEX"

AMMONIUM NITRATE, INDUSTRIAL
Allied Chemical Corp., Nitrogen Div.
American Cyanamid Co., Explosives & Mining Chemicals Dept. —"AEROPRILLS®"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Hercules Powder Co.
Industrial Chemicals Div., Spencer Chemical Co.—"N-IV"
National Powder Co.

AMMONIUM-NITRATE LOADERS—See Explosives Loaders, Pneumatic

AMMONIUM-NITRATE PRIMER-INITIATORS, BOOSTERS See Boosters, Ammonium Nitrate

ANALYZERS, COAL-SULPHUR
Fisher Scientific Co.
Laboratory Equipment Co.—"LECO"

ANALYZERS, GAS
Hays Corp.

ANALYZERS, VOLATILIZATION
Laboratory Equipment Co.—"LECO"

ANEMOMETERS
Fisher Scientific Co.
Mine Safety Appliances Co.
National Mine Service Co.

ANTIFOAM AGENTS
Hodag Chemical Corp.

ANTI-FOG GOGGLE CLEANER
American Optical Co., Safety Products Div.—"SUPER-CLEAR"
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.—"FOGPRUF"
United States Safety Service Co.

ANTIFREEZE
American Minechem Co.
American Oil Co.
E. I. du Pont de Nemours & Co., Inc.—"TELAR®" "ZERONE®" "ZEREX®"

ARCHES, ROOF-SUPPORT— See Roof Supports, Yieldable-Arch

ARCHES SUSPENDED FURNACE
Bigelow-Liptak Corp.

ARMATURE GROWLERS, TESTERS, TOOLS
Martindale Electric Co.
Snap-on Tools Corp.—"SNAP-ON"

ARMATURE REWINDING
Flood City Brass & Electric Co.
Guyan Machy. Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

ASHING EQUIPMENT, RAPID
Laboratory Equipment Co.—"LECO"

ATHLETE'S-FOOT PREVENTIVE
Onox, Inc.—"ONOX"

AUDIO SYSTEMS
National Mine Service Co.—"FEMCO"

AUGER DRIVE PINS
Central Mine Equipment Co.

AUGER FLIGHTS, EXTENSIONS, FOR USE IN COAL
Acker Drill Co., Inc.
Central Mine Equipment Co.—"COALMASTER"
Dooley Brothers
Howells Mining Drill Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Tool Div.
The Leetonia Tool Co.
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
National Mine Service Co.
Paris Mfg. Co.
The Salem Tool Co.—"McCARTHY"
Schroeder Brothers Corp.
Taylor-Wharton Co. Div., Harsco Corp.
Thor Power Tool Co.

AUGER FLIGHTS, EXTENSIONS FOR USE IN EARTH & ROCK
Acker Drill Co., Inc.
Central Mine Equipment Co.—"COALMASTER"
Dooley Brothers
Howells Mining Drill Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Tool Div.
The Leetonia Tool Co.
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
National Mine Service Co.
Paris Mfg. Co.
The Salem Tool Co.—"McCARTHY"
Schroeder Brothers Corp.
Taylor-Wharton Co. Div., Harsco Corp.
Thor Power Tool Co.

AUGER HEADS, CUTTERS, FOR USE IN COAL
McLaughlin Mfg. Co., Inc.

AUGER HEADS, CUTTERS, FOR USE IN EARTH & ROCK
Acker Drill Co., Inc.
The Leetonia Tool Co.
Long-Airdox Co.
Mobile Drilling, Inc.

AUGER SOCKETS
The Leetonia Tool Co.
Long-Airdox Co.
Mobile Drilling, Inc.

AUGERS, BREAST
The Salem Tool Co.—"SALEM"

AUGERS, COAL-RECOVERY, SURFACE USE
Joy Mfg. Co.
Long-Airdox Co.
The Salem Tool Co.—McCARTHY (Gasoline, diesel, electric)

AUGERS, COAL-RECOVERY, EARTH BORING, UNDERGROUND
Joy Mfg. Co.
Long-Airdox Co.
The Salem Tool Co.—"McCARTHY"

AUGERS, COAL-SHOTHOLE
Central Mine Equipment Co.—"COALMASTER"
Dooley Bros.
Kennametal Inc., Mining Tool Div.
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Metallurgical Products Dept. General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
The Salem Tool Co.—"HERCULES"
Schroeder Bros. Corp.

AUGERS, EARTH
Acker Drill Co., Inc.—"ALL-PURPOSE (AP) AUGER-DRILL"
Central Mine Equipment Co.—"CME," "COALMASTER"
H & L Tooth Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
The Leetonia Tool Co.
Link-Belt Co., Dept. CAMGL—61
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
Pennsylvania Drilling Co.
The Salem Tool Co.—"BLACK DIAMOND"
The Wood Shovel & Tool Co.

AUGERS, ROCK-BLASTHOLE
Central Mine Equipment Co.—"CME"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Long-Airdox Co.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
The Salem Tool Co.—"McCARTHY"

AUGERS, ROOF DRILL
Central Mine Equipment Co.
Kennametal Inc., Mining Tool Div.
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.—(including internal dust collector rods)

AUTOMATIC SPRINKLERS
The Fyr-Fyter Co.

AXLES FOR CARS, MINE EQUIPMENT
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co. —"GEMCO TRU-BLU"
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Sanford-Day Corp.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

AXLES, AUTOMOTIVE DRIVING, NONDRIVING, STEERING, ETC.
Clark Equip. Co., Automotive Div.

AXLES, FRONT, (DRIVING-NONDRIVING); SINGLE, TANDEM; PLANETARY (STEERING-RIGID), WORM
Rockwell Standard Corp., Transmission and Axle Div.

BABBITT METAL
American Brake Shoe Co., National Bearing Div.

BACK RIPPERS, BULLDOZER
Preco Incorporated—"PRECO"

BACKSTOPS
American Pulley Co.
Barber-Greene Co.
Chain Belt Co.—"REX"
Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co., Dept. CAMGL-61
Marland One-Way Clutch Co.
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Webster Mfg., Inc.

BAGS, AIR-FILTERS, DUST COLLECTORS
Bemis Bro. Bag Co.
C. R. Daniels Co.
The Ducon Co., Inc.
Koppers Co., Inc., Metal Products Div.
National Filter Media Corp.
Western Precipitation Div., Joy Mfg. Co., "DUALAIRE," "THERM-O-FLEX"
Wheelabrator Corp.

BAGS, AMMONIUM NITRATE, NITRO-CARBO-NITRATE
Bemis Bro. Bag Co.

BAGS, COAL-DRYING FILTERS
The Eimco Corp.
Filtration Engineers Div.—American Machine & Metals, Inc.
National Filter Media Corp.
Peterson Filters & Engineering Co. (stainless wire)

BAGS, EXPLOSIVES
American Brattice Cloth Co.
Bemis Bro. Bag Co.
C. R. Daniels Co.
Mine Safety Appliances Co.
National Powder Co.
Tamping Bag Co. Div., Pickard Industries, Inc.

BAGS, POLYETHYLENE
Bemis Bro. Bag Co.—"FLIP-CLOSE," "FINE-WELD," "FLAP-LOK," "RE-CLOS-IT"
Chase Bag Co.
The Eimco Corp.
Peterson Filters & Engineering Co.—"SARAN"
Tamping Bag Co. Div., Pickard Industries, Inc.
Trojan Powder Co.

BAGS, TAMPING
American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.
Bemis Bro. Bag Co.
Chase Bag Co.
E. I. du Pont de Nemours & Co., Inc.
National Mine Service Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Tamping Bag Co., Div., Pickard Industries, Inc.

BALLS, STEEL
New Departure Div., General Motors Corp.
SKF Industries, Inc.

BARGE-HANDLING EQUIPMENT
Connellsville Corp.
Dravo Corp.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Company, Division of Thompson Starret Company, Inc.
Sanford-Day Corp.
Stephens-Adamson Mfg. Co.

BARGES
Bethlehem Steel Co.
Dravo Corp.
Marietta Manufacturing Co.
Wiley Manufacturing Co.

BAROGRAPHS
American Paulin System—"MICRO" "TERRA"

BAROMETERS
American Paulin System—"MICRO," "TERRA"
The Bristol Co.—"BRISTOLS"
Fisher Scientific Co.

BARRICADING KIT
Mine Ventilation Systems, Inc.

BARS, APPLICATOR
Stulz-Sickles Co.—"MANGANAL"

BARS, COLD-FINISHED
H. K. Porter Co., Connors Steel Div.—"CONNORS"

BARS, GRIZZLY
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Hewitt-Robins Incorporated
Kensington Steel, Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starret Company, Inc.

BARS, MERCHANT
Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"CONNORS"

BARS, REINFORCING— See Concrete Reinforcing Bars

BARS, SLATE
Duquesne Mine Supply Co.
The Leetonia Tool Co.
The Salem Tool Co.—"SALEM"

BARS, TAMPING
Bethlehem Steel Co.
Gibralter Equipment & Mfg. Co.

BASKETS, CLOTHES
C. R. Daniels Co.
The Moore Co.—"LOCKER-BASKETS"

BATTERIES, DRY
United States Rubber Co.

BATTERIES, SHOT-FIRING
National Mine Service Co.

BATTERIES, STORAGE
C & D Batteries, Div. The Electric Autolite Co.—"SLYVER-CLAD®," "PLASTICELL," "PLASTICAL®"
Thomas A Edison Industries, McGraw-Edison Co., Storage Battery Div.—"EDISON"

Exide Industrial Marketing Div., The Electric Storage Battery Co.—"EXIDE-IRONCLAD," "EXIDE NICKEL IRON" "EXIDE POWERCLAD"
Goodyear Tire & Rubber Co.
Gould-National Batteries, Inc.
Joy Mfg. Co.
Kersey Mfg. Co. Inc.
National Mine Service Co.
Westinghouse Electric Corp.
Yardney Electric Corp.—"YARDNEY SILVERCEL," "YARDNEY SILCAD"

BATTERY-CHARGING EQUIPMENT

Acme Electric Corp.—"MAGNISTROL"
C & D Batteries, Div. The Electric Autolite Co.—"AUTO-REG®"
Exide Industrial Marketing Div., The Electric Storage Battery Co.—"EXIDE VERTICAL MOTOR-GENERATORS," "EXIDE HORIZONTAL MOTOR-GENERATORS," "EXIDE ETR RECTIFIERS"
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.—"GS"
Gould-National Batteries, Inc.
Hobart Bros. Co.
The Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Kersey Mfg. Co., Inc.
The Lincoln Electric Co.—"PRECISION-CHARGE"
Mine-Safety Appliances Co.
Syntron Co.

BEARING MATERIAL, PHENOLIC RESIN

American Brakeblok Div., American Brake Shoe Co.

BEARING METAL

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO"
Bearings, Inc.
Crucible Steel Co. of America
Imperial-Cantrell Mfg. Co.—"IC"
Joseph T. Ryerson & Son, Inc.
Webster Mfg., Inc.
West Virginia Armature Co.

BEARING OILERS

Herold Mfg. Co.

BEARINGS, BALL

Bantam Bearings Div., Torrington Co.
Bearings Service Co.
Bearings, Inc.
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SC," "SLP," "SCM"
Ensign Electric & Mfg. Co.
The Fafnir Bearing Co.—"FAFNIR"
The Federal Bearings Co., Inc.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BCA"
Flood City Brass & Electric Co.
Link-Belt Co.—Dept. CAMGL-61—"JPS"
Marlin-Rockwell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
National Mine Service Co.
New Departure Div., General Motors Corp.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Ore Reclamation Co.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Torrington Co.
Transall, Inc.
T. B. Woods Sons Co.—"LIFE LUBE"
West Virginia Armature Co.

BEARINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
Link-Belt Co., Dept. CAMGL-61
McLanahan Corp.

BEARINGS, CARBON

Helwig Carbon Products, Inc.
Ohio Carbon Co.—"KARAK"
Pure Carbon Co., Inc.
Stackpole Carbon Co.

BEARINGS, HANGER

Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-61
Tulsa Products Div. Vickers, Inc.—"TULSA (Two speed)"

BEARINGS, JOURNAL

American Brake Shoe Co., National Bearing Div.
American Brake Shoe Co., Railroad Products Div.
Dodge Mfg. Corp.

BEARINGS, NEEDLE

Bantam Bearings Div., Torrington Co.
Bearings Service Co.
Bearings, Inc.
Torrington Co.

BEARINGS, ROLLER

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Chain Belt Co.—"SHAFER"
Chain Belt Co., Shafer Bearing Div.—"SHAFER SELF-ALIGNING"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SPHER-ALIGN"
Enterprise Wheel & Car Corp.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BOWER"
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT," "MILL BEARING," "SPHERICAL"
Marlin-Rockwell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
National Mine Service Co.
Norma-Hoffmann Bearings Corp.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Torrington Co.
West Virginia Armature Co.

BEARINGS, ROLLER, SPLIT

Bearing Service Co.
Bearings, Inc.
Link-Belt Co., Dept. CAMGL-61
Transall, Inc.

BEARINGS, SLEEVE

Allison Div., General Motors Corp.
American Brake Shoe Co., National Bearing Div.
American Crucible Products Co.
Ampco Metal, Inc.—"AMPCO"
Bearings, Inc.
Dodge Mfg. Corp.—"SLEEVOIL"
Flood City Brass & Electric Co.
Imperial-Cantrell Mfg. Co.—"IC"
Link-Belt Co., Dept. CAMGL-61—"FLEX-BLOCK" (including self-aligning)
Bertrand P. Tracy Co.
Transall, Inc.
Webster Mfg., Inc.
West Virginia Armature Co.

BEARINGS, SLEEVE, CONVERSION

Bearings, Inc.
Imperial-Cantrell Mfg. Co.—"IC"
West Virginia Armature Co.

BEARINGS, SLEEVE, SELF-LUBRICATING

Keystone Carbon Co.
Link-Belt Co., Dept. CAMGL-61—"FLEX-BLOCK"

BEARINGS, TAPERED ROLLER

Dodge Mfg. Corp.
Federal-Mogul Service, Div. of Federal-Mogul-Bower Bearings, Inc.—"BOWERS"
SKF Industries, Inc.—"TYSON"
The Timken Roller Bearing Co.
Tyson Bearing Co., Div. of SKF Industries, Inc.

BEARINGS, THRUST

Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Federal-Mogul Service Div. of Federal-Mogul-Bower Bearings, Inc.—"BCA"
Gibraltar Equipment & Mfg. Co.—"FRICTION FIGHTER"
The Federal Bearings Co. Inc.
Link-Belt Co., Dept. CAMGL-61
Marlin-Rockwell Corp.—"M-R-C"
New Departure Div., General Motors Corp.
Norma-Hoffmann Bearings Corp.
SKF Industries, Inc.
Torrington Co.

BELT CLAMPS

Transall, Inc.

BELT-LOADING STATIONS, AUTOMATIC

Link-Belt Co., Dept. CAMGL-61
The Nolan Co.

BELTS, CHAIN

Link-Belt Co., Dept. CAMGL-61

BELTS, FLAT TRANSMISSION

Bando Rubber Mfg. Co., Ltd.—"SUN," "SUCCESS," "ATLAS"
American Biltrite Rubber Co., Boston Woven Hose & Rubber Co. Div.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
C. R. Daniels Co.
Extremultus, Inc.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.—"HIGH FLEX"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Manheim Mfg. & Belting Co.
Ore Reclamation Co.
Paltech Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"CONDOR"
Republic Rubber Div., Lee Rubber & Tire Co.—"CHALLENGER"
Scandura, Inc.—"SCANDINAVIA," "SCANDILEX"
Thermoid Div., H. K. Porter Co. Inc.
Transall, Inc.
United States Rubber Co.

BELTS, MINER'S LEATHER

National Mine Service Co.

BELTS, V

American Pulley Co.
American Biltrite Rubber Co., Boston Woven Hose & Rubber Co. Div.—"BOSTON," "BOSTRON"
Bando Rubber Mfg. Co. Ltd.—"BANROPE"
Browning Mfg. Co.—"GRIP-BELTS," "SUPER GRIP-BELTS," "STEEL CABLE GRIPBELTS," "358," "GRIP-BELTS," "GRIPROLL," "GRIPLINK," "VARIABLE SPEED," "POLY-V," "GEAR-BELT"
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Dodge Mfg. Corp.—"SEALED-LIFE," "DYNA-V"
Extremultus, Inc.
Flood City Brass & Electric Co.
The Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.—"GROMMET"
Goodyear Tire & Rubber Co.
National Mine Service Co.
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"CONDOR," "SUPER-POWER"
Republic Rubber Div., Lee Rubber & Tire Co.—"CHAMPION"
Thermoid Div., H. K. Porter Co., Inc.
Transall, Inc.
United States Rubber Co.
T. B. Woods Sons Co.—"SURE GRIP"
Worthington Corp.

BELTS, V-LINK

National Mine Service Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
T. B. Woods Sons Co.—"SURE-LINK"

BELTS, V-LINK ADJUSTABLE

Manheim Mfg. & Belting Co.—"VEELOS V"

BENDERS, PIPE, BAR STOCK, ANGLE IRON, O. D. TUBING, RIGID CONDUIT

Blackhawk Industrial Div.
Farrell-Cheek Steel Co.
Hossfeld Mfg. Co.—"HOSSFELD UNIVERSAL"
National Electric, Div. H. K. Porter Co., Inc.

BINDERS, LOAD

American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.
Coffing Hoist Div., Duff-Norton Co.
Crosby Laughlin Div. American Hoist & Derrick Co.—"LEBUS"
Gibraltar Equipment & Mfg. Co.

BIN GATES

C. S. Card Iron Works
Chain Belt Co.—"REX"
Galis Electric & Machine Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Iowa Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
Smith Engineering Works—"TELSMITH," "MOORE," "DUPLEX," "TRIPLEX"
Stephens-Adamson Mfg. Co.
Templeton-Matthews Corp.
G. C. Thomas Mfg. Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

BIN-LEVEL INDICATORS

The Bin-Dicator Co.—"BINDICATOR," "BANTAM BINDICATOR," "ROTO BINDICATOR," "AUTO-BIN-DICATOR"
Convair—"BIN-VUE"
Hewitt-Robins Incorporated—"ROBINTRONIC"
Industrial Physics & Electronics Co.—"TRANSIST-O-TROL"
Jeffrey Mfg. Co.—"BIN-EYE"
Stephens-Adamson Mfg. Co.—"TELEVEL"

BIN OUTLETS, NON PLUGGING

The Bin-Dicator Co.—"BIN-DICATOR HYPERBOLIC"

BIN VIBRATORS

The Branford Co.—"BRANFORD"
Cleveland Vibrator Co.—(air & electric)
Eriez Mfg. Co.
W. S. Tyler Co.—"TY-SPEED"

BINS, PARTS-STORAGE

The Frick-Gallagher Mfg. Co.—"ROTABINS"
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

BINS & HOPPERS, COAL-STORAGE, BLENDING, SLATE

Barber-Greene Co.
Bethlehem Steel Co.
The Daniels Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Enterprise Wheel & Car Corp.
Galis Electric & Machine Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Koven Fabricators, Inc.
Link-Belt Co., Dept. CAMGL-61
Meckum Engineering, Inc.
Marietta Concrete Div., American-Marietta Co.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
The Neff & Fry Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
Templeton-Matthews Corp.
G. C. Thomas Mfg. Co.

BIT BOXES

Duquesne Mine Supply Co.

BIT HOLDERS, MULTIPLE, INDIVIDUAL

Frank Prox Co., Inc.

BIT RESETTING SERVICE, DIAMOND

Hoffman Bros. Drilling Co.
Joy Mfg. Co.
J. K. Smit & Sons, Inc.
Sprague & Henwood

BIT SHARPENERS, COAL BITS

Joy Mfg. Co.

BIT SHARPENERS, ROCK BITS

Bucyrus-Erie Co.
Hoffman Bros. Drilling Co.
Ingersoll-Rand Co.
Joy Mfg. Co.

BIT-SHARPENING SERVICE

Brunner & Lay-Eastern, Inc.
Fairview Bit Co.
Hoffman Bros. Drilling Co.
Howells Mining Drill Co.

BITS, CUTTER

Herold Mfg. Co.

BITS, CUTTER, ALLOY-STEEL

The Bowdil Co.
Central Mine Equipment Co.—"KERFMASTER"
Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX."
Crucible Steel Co. of America—'REX"
Cutter Bit Service Co.—"CUT-RITE"
Long-Airdox Co.

BITS, CUTTER CARBIDE-INSERT

Allegheny Ludlum Steel Corp.—"CARMET"
Austin Powder Co.
The Bowdil Co.
Cincinnati Mine Machinery Co.—"CINIDE," "RAP-LOK"
Cutter Bit Service Co.—"CUT-RITE"
Firth Sterling, Inc.—"FIRTH-ITE"
Hoffman Bros. Drilling Co.
Kennemetal, Inc., Mining Tool Div.
Long-Airdox Co.
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.—"CAR-BOLOY"
Mobile Drilling, Inc.
National Mine Service Co.
Frank Prox Co., Inc.—"PT-1," "PT-2," "PT-3"
The Salem Tool Co.—"SALEM"
Vascoloy-Ramet Corp.

BITS, CUTTER, CARBON-STEEL

Austin Powder Co.
Crucible Steel Co. of America
Cutter Bit Service Co.—"CUT-RITE"
Howells Mining Drill Co.
The Leetonia Tool Co.

BITS, CUTTER, HARD-SURFACED, TIPPED

The Bowdil Co.
Central Mine Equipment Co.—"KERFMASTER"
Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"
Cutter Bit Service Co.—"CUT-RITE"
Long-Aidrox Co.
Mobile Drilling, Inc.
Frank Prox Co., Inc.

BITS, CUTTER, THROWAWAY

The Bowdil Co.
Central Mine Equipment Co.—"KERFMASTER"
Cincinnati Mine Machinery Co.—"DUPLEX," "STANEX"
Cutter Bit Service Co.—(Cincinnati, Bowdil)
Hoffman Bros. Drilling Co.
Long-Airdox Co.
Marathon Coal Bit Co. Inc.—"MARATHAN."
Mobile Drilling, Inc.
National Mine Service Co.
Penn Machinery Co.
Frank Prox Company, Inc.—"TOOL STEEL"

BITS, DRILL, CHURN

Spang & Co.

BITS, DRILL, COAL

Austin Powder Co.
Central Mine Equipment Co.—"COALMASTER"
Dooley Brothers
Gibraltar Equipment & Mfg. Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Howells Mining Drill Co.
Joy Mfg. Co.
Kennemetal Inc., Mining Tool Div.
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling, Inc.
National Mine Service Co.
Paris Mfg. Co.
The Salem Tool Co.—"SALEM"

BITS, DRILL, COAL, CARBIDE-TIPPED

Allegheny Ludlum Steel Corp.—"CARMET"
Austin Powder Co.
Brunner & Lay-Eastern, Inc.
Firth Sterling, Inc.—"FIRTH-ITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Howells Mining Drill Co.
Kennemetal Inc., Mining Tool Div.
Long-Airdox Co.
McLaughlin Mfg. Co., Inc.
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY," "BORDER CITY"
Mobile Drilling, Inc.
Paris Mfg. Co.
Frank Prox Company, Inc.
The Salem Tool Co.—"SALEM"
Vascoloy-Ramet Corp.

BITS, DRILL, CORE

Acker Drill Co. Inc.
Central Mine Equipment Co.
George E. Failing Co., Sub. of Westinghouse Air Brake Co.
Hoffman Bros. Drilling Co.
Joy Mfg. Co.
Kennemetal Inc., Mining Tool Div.
Mobile Drilling, Inc.
Pennsylvania Drilling Co.
Sprague & Henwood

BITS, DRILL, DIAMOND

Diamond Tool Research Co., Inc.—"DTR"
George E. Failing Co., Sub. of Westinghouse Air Brake Co.
Hoffman Bros. Drilling Co.
Joy Mfg. Co.—"TRUCO"
Metal Carbides Corp.
Mobile Drilling, Inc.
Pennsylvania Drilling Co., Masonry Drill Div.
J. K. Smit & Sons, Inc.—"HAR HED"
Sprague & Henwood
Varel Mfg. Co., Inc.

BITS, DRILL, MASONRY

Pennsylvania Drilling Co., Masonry Drill Div.

BITS, DRILL, MOLEFOOT, STRIPPING

Central Mine Equipment Co.—"COALMASTER"
Long-Airdox Co.
Paris Mfg. Co.
The Salem Tool Co.—"SALEM"

BITS, DRILL, PERCUSSION

Acme Machinery Co.
Brunner & Lay-Eastern, Inc.
Bucyrus-Erie Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Schroeder Brothers Corp.

BITS, DRILL, PERCUSSION, CARBIDE-TIPPED

Allegheny Ludlum Steel Corp.
Brunner & Lay-Eastern, Inc.—"ROK-BITS"
Firth Sterling Inc.—"FIRTHITE"
Joy Mfg. Co.
Ingersoll-Rand Co.—"CARSET"
Long-Airdox Co.
Metal Carbides Corp.
The Timken Roller Bearing Co.
Vascoloy-Ramet Corp.

BITS, DRILL, ROOF, CARBIDE-TIPPED

Allegheny Ludlum Steel Corp.—"CARMET"
Austin Powder Co.
Brunner & Lay-Eastern, Inc.—"INTRASET"
Firth Sterling, Inc.—"FIRTHITE"
J. H. Fletcher & Co. (Key Type)
Kennametal Inc., Mining Tool Div.
Long-Airdox Co.
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Frank Prox Company, Inc.
Vascoloy-Ramet Corp.

BITS, DRILL, ROTARY

Varel Mfg. Co., Inc.—"AIR BLAST"

BITS, DRILL, ROTARY, AIR, BLASTHOLE

Acker Drill Co., Inc.
Austin Powder Co.
Central Mine Equipment Co—"COALMASTER"
Chicago Pneumatic Tool Co.
George E. Failing Co., Sub. of Westinghouse Air Brake Co.
Firth Sterling, Inc.—"FIRTHITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Hughes Tool Co.—"ROTA-BLAST"
Kennemetal Inc., Mining Tool Div.
Long-Airdox Co.
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Security Engrg. Div., Dresser Industries, Inc.—"SUPERAIRE"
Smith Tool Co.
Varel Mfg. Co., Inc.—"AIR-BLAST"
Vascoloy-Ramet Corp.

BITS, DRILL, ROTARY, WET, BLASTHOLE

Central Mine Equipment Co.—"CME"
Chicago Pneumatic Tool Co.
Firth Sterling, Inc.—"FIRTH-ITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling Co.
Long-Airdox Co.
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Security Engrg. Div., Dresser Industries, Inc.
Smith Tool Co.
Varel Mfg. Co., Inc.
Vascoloy-Ramet Corp.

BITS, FINGER, CARBIDE-TIPPED

Central Mine Equipment Co.—"COALMASTER"
Firth Sterling Inc.—"FIRTHITE"
Long-Airdox Co.
Vascoloy-Ramet Corp.

BITS, ROTARY, REPLACEMENT BLADES & CONES

Varvel Mfg. Co., Inc.

BLADE CONTROLS, AUTOMATIC-GRADER

Preco Incorporated—"PRECO"

BLANKS, CARBIDE MINING BIT

Metal Carbides Corp.

BLASTING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"CYAMITE," "ACCOMITE," "CYAMON"—"CYAMON OS"®
Atlas Powder Co.—"AMOCOL" "AMOFLO," "CHEMEX," "ATLAS GRANULES," "ATLAS PRILLS," "GIANITE" "ATLAS PELLETS"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.—"NILITE," "NITRAMEX®," NITRAMITE®," NITRAMON®"
Hercules Powder Co.

BLASTING CAPS

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.—"MANASITE" "ROCKMASTER," "KOLMASTER"
E. I. du Pont de Nemours & Co., Inc.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.—"BIG INCH"
Trojan Powder Co.

BLASTING MACHINES

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.—"SHOTMASTER," "FEMCO"
Hercules Powder Co.
Trojan Powder Co.
Vibration Measurement Engineers—"VME BLASTER" (Condenser Discharge)

BLASTING METERS

Hercules Powder Co.—"VAO"
Trojan Powder Co.

BLASTING WIRE, CORD

American Cyanamid Co., Explosives and Mining Chemicals Dept.
Atlas Powder Co.
Cornish Wire Co., Inc., Div. of General Cable Corp.
E. I. du Pont de Nemours & Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Rome Cable Corp.
Trojan Powder Co.

BLENDERS

McLanahan Corp.

BLENDING AND PROPORTIONING SYSTEMS

ABCs® Scale Div., McDowell Co., Inc.

BLOCK SIGNALS, AUTOMATIC

American Mine Door Co.
General Equipment & Mfg. Co.
Nachod & U.S. Signal Co.

BLOCKS, WHEEL

The Aldon Co.

BLOCKS, WIRE-ROPE

Crosby-Laughlin Div., of American Hoist & Derrick Co.—"CROSBY," "DEBUS," "McKISSICK"
Joy Mfg. Co.
Sauerman Bros., Inc.—"DURO-LITE"
The Upson-Walton Co.

BLOWERS, CENTRIFUGAL

Allis-Chalmers Mfg. Co.
Buffalo Forge Co.—"BUFFALO"
E. K. Campbell Co.—"EKCCO"
Clarage Fan Co.
Coppus Engineering Corp.
Hauck Mfg. Co.
Ilg Electric Ventilating Co.—"ILG"
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Robinson Ventilating Co.
Roots-Connersville Blower, Div. Dresser Industries, Inc.
Westinghouse Electric Corp.
Westinghouse Electric Corp., Sturtevant Div.

BLOWERS, CIRCULATING, DRAFT

Buffalo Forge Co.—"BUFFALO"
E. K. Campbell Co.—"EKCCO"
Clarage Fan Co.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.—"AXIVANE"
Sanford-Day Corp.
Westinghouse Electric Corp., Sturtevant Div.

BLOWERS, CLEANING, MAINTENANCE

American Mine Door Co.—"ACE"
Holub Industries, Inc.
Joy Mfg. Co.—"AXIVANE"
Martindale Electric Co.

BLOWERS, PORTABLE, MINE

Buffalo Forge Co.—"BUFFALO"
Coppus Engineering Corp.—"VANO," "VENTAIR"
Herold Mfg. Co.
Jeffrey Mfg. Co.—"AERODYNE"
Joy Mfg. Co.—"AXIVANE"
Mine Safety Appliances Co.
Morse Bros. Machinery Co.
Roots-Connersville Blower Div. Dresser Industries, Inc.

BLOWERS, ROTARY

Roots-Connersville Blower Div. Dresser Industries, Inc.

BOAT LOADING & UNLOADING EQUIPMENT

Hewitt-Robins Incorporated.

BOILERS, HEATING, HOT-WATER, STEAM

American-Standard Industrial Div.
Axeman-Anderson Co.
Crane Co.
Dallas Engineers Inc., Coal-O-Matic Div.—"ANTHRAFLO," "COAL-O-MATIC"
Koven Fabricators Inc.

BOLTS

Bethlehem Steel Co.
Duquesne Mine Supply Co.—"REDIPT"
Republic Steel—"REPUBLIC"
Sheffield Div., Armco Steel Corp.

BOLTS, TRACK—See Rail Bolts

BONDS, RAIL—See Rail Bonds

BOOSTERS, AIR/OIL, SINGLE STROKE

Ledeen, Inc.

Special report to users of Cat D6 and D7 track parts

CAT CATERPILLAR

Parts you can trust
...cost less per hour

Up to 25% Longer Link Life at No Increase in Cost

New track links have rails hardened deeper than any other brand . . . hardness with file-like, wear-resistant qualities

You can't "see" metallurgy and heat treatment in track links. But you'll definitely see the *results* in the extra life you get from the *new* Cat D6 and D7 track links. These superior links will outlast all other brands yet the suggested price is no higher than before.

D6, 955 AND 561 LINKS

- "Hi-Electro" hardened rails give outstanding wear life.
- Rail wear cases are twice as deep as other brands.
- Closer bore tolerances retain pins and bushings better.
- Full 1¼" top rail surface to pin boss clearance allows more wear before roller flange contact.

D7, 977 AND 572 LINKS

- 12% thicker rails eliminate peening, rebuilding distortion.
- 32% thicker struts and more steel in critical areas increase over-all strength, resist cracking.
- File-hard "Hi-Electro" hardened rails withstand abrasive wear.
- Uniform, wear-resistant rail cases deeper than other makes.

These new track links are made from special steel, carefully pretested *before* manufacture. They're forged, machined and heat treated to develop maximum strength and toughness. A non-peenable wear barrier is induced *deeply* into rail top and sides by exclusive "Hi-Electro" hardening. This exacting heat treatment permits maximum, file-like wear resistance without brittleness.

Try the new links . . . and the many other *special-purpose* tractor undercarriage parts, all designed and built to keep your cost-per-hour to a minimum. Cat undercarriage specialists can help you select right combinations and give you money-saving recommendations tailored to your particular needs. It's all a part of your Dealer's Custom Track Service . . . the practical approach to lowering undercarriage costs by extending part life and machine availability through proper parts selection and parts care.

Etched rail cross-section shows deep, uniform wear case found on top and sides of new links.

CATERPILLAR

Caterpillar Tractor Co., General Offices,
Peoria, Illinois, U. S. A.

BOOSTERS, AMMONIUM-NITRATE

Propellex Chemical Div., Chrom-Alloy Corp.—"SAF-T-BOOST"
Spencer Chemical Co.—"SPEN-ITE"
Trojan Powder Co.

BOX-CAR LOADERS

The Eimco Corp.
Link-Belt Co., Dept. CAMGL-61 —"JETSLINGERS"
Lippmann Engrg. Works
Morse Bros. Machinery Co.
Stephens-Adamson Mfg. Co.—"SWIVELOADERS," "SINDEN"

BOX-CAR UNLOADERS

Link-Belt Co., Dept. CAMGL-61 —"LINK BELT," "KARFLO," "ROTARY-MINE-CAR"
Stephens-Adamson Mfg. Co.

BOXES, DETONATOR

J. V. Hammond Co.
Mine Safety Appliances Co.

BOXES, POWDER, SAFETY

E. I. du Pont de Nemours & Co., Inc.
J. V. Hammond Co.
Mine Safety Appliances Co.

BRAKE BLOCKS

Irwin-Sensenich Corp.
Johns-Manville—"J-M"
Raybestos Manhattan, Inc. Manhattan Rubber Div.
Thermoid Co.
Wagner Electric Corp.
S. K. Wellman Co.—"VELVE-TOUCH FERAMIC" (¾ in only)

BRAKE BLOCKS, WOOD

Enterprise Wheel and Car Corp.
J. V. Hammond Co.
Irwin-Sensenich Corp.

BRAKE FLUID, HYDRAULIC

Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
United States Rubber Co.

BRAKE FRICTION, LINING

American Brakeblok Div., American Brake Shoe Co.
Goodyear Tire & Rubber Co.
Johns-Manville—"J-M"
Mining Machine Parts Inc.
Raybestos Manhattan, Inc. Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
Wagner Electric Corp.
S. K. Wellman Co.—"VELVE-TOUCH"

BRAKE MOTORS

The Master Electric Co., Div. of Reliance Electric & Engrg. Co.
Reliance Electric and Engrg. Co.

BRAKE SHOES, COMPOSITION

American Brake Shoe Co., Railroad Products Div.

BRAKE SHOES, METALLIC

American Brake Shoe Co., Railroad Products Div.
Duquesne Mine Supply Co.—"FERALUN"
Flood City Brass & Electric Co.
Helmick Foundry-Machine Co.
National Mine Service Co.

BRAKES, HIGH-TORQUE

B. F. Goodrich Aviation Products

BRAKES, LINING

S. K. Wellman Co.—"VELVE-TOUCH"

BRAKES, LOCOMOTIVE

Goodyear Tire & Rubber Co.
Helmick Foundry-Machine Co.
National Mine Service Co.

BRAKES, MAGNETIC

Clark Controller Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

BRAKES, MAGNETIC, EDDY-CURRENT

Eaton Mfg. Co., Dynamatic Div., "AJUSTO-BRAKE"

BRAKES, MAGNETIC, FRICTION

Eaton Manufacturing Co., Dynamatic Div.—"DYNATORQ"

BRAKES, MINE-CAR

American Car & Foundry Div. ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibralter Equipment & Mfg. Co. —"GEMCO TRU-BLU"
Goodyear Tire & Rubber Co.
Helmick Foundry-Machine Co.
Irwin-Sensenich Corp.

BRAKES, TRUCK, AIR

Eaton Mfg. Co., Axle Div.
Rockwell-Standard Corp., Brake Div.
Wagner Electric Corp.

BRAKES, TRUCK, HYDRAULIC

Rockwell-Standard Corp., Brake Div.
Wagner Electric Corp.

BRAKES, TRUCK HYDRO-DYNAMIC AUXILIARY

The Parkersburg Rig & Reel Co., Div. of Parkersburg-Aetna Corp.—"HYDROTARDER"

BRAKES, TRUCK, MECHANICAL

Rockwell-Standard Corp., Brake Div.

BRATTICE CLOTH

American Brattice Cloth Co.
C. R. Daniels Co.
Goodrich Co., B. F., Industrial Products Div.—"KOROSEAL"
National Mine Service Co.

BREAKERS, COAL, ROTARY

Heyl & Patterson, Inc.—"BRADFORD"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Templeton-Matthews Corp.

BREAKERS, PAVING

Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Le Roi Div., Westinghouse Air Brake Co.
Syntron Co.
Thor Power Tool Co.

BREAKERS, PAVING, ELECTRIC

Homelite, a div. of Textron, Inc. —"HOMELITE (BOSCH)"

BREAKERS, PICK-TYPE, PREPARATION

McNally-Pittsburg Mfg. Corp.

BREATHING APPARATUS

American Optical Co., Safety Products Div.
Mine Safety Appliances Co.—"CHEMOX," "McCAA TWO-HOUR"

BRIDGES, COAL HANDLING

Dravo Corp.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61

BRUSH HOLDERS

Link-Belt Co., Dept. CAMGL-61
National Mine Service Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

BRUSHES, CARBON, GRAPHITE, ELECTRO-GRAPHITIC, METAL-GRAPHITE

Flood City Brass & Electric Co.
Helwig Carbon Products, Inc.
National Carbon Co., Div. of Union Carbide Corp.
National Mine Service Co.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Stackpole Carbon Co.
Standard Carbon Co.
Superior Carbon Products, Inc.
West Virginia Armature Co.
Westinghouse Electric Corp.

BUCKET CHAINS, DRAGLINE

Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-61 (roller chain)

BUCKET TEETH, BASES, INSERTS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Steel Foundries—"WEARPACT"
Blaw-Knox Co., Blaw-Knox Equipment Div.
Bucyrus-Erie Co.
ESCO CORP.—"ESO"
H & L Tooth Co.
Kensington Steel, Div. of Poor & Co.
Page Engineering Co.
Taylor-Wharton Co., Div. Harsco Corp.

BUCKET-TEETH REPOINTERS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Kensington Steel, Div. of Poor & Co.
Stulz-Sickles Co.—"WING-DING" "SS CRESCENT"
Taylor-Wharton Co., Div. Harsco Corp.

BUCKETS, AERIAL TRAMWAY

Irwin Sensenich Corp.
Watt Car & Wheel Co.

BUCKETS, CLAMSHELL

Blaw-Knox Co., Blaw-Knox Equipment Div.
ESCO Corp.
Pettibone Mulliken Corp., Haiss Div.
Heyl & Patterson, Inc.
McDowell Co. Inc.—"WILLIAMS"
Salem-Brosius, Inc.
Schield Bantam Co.

BUCKETS, ELEVATOR

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Enterprise Wheel and Car Corp.
Farrell-Cheek Steel Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Laubenstein Mfg. Co.
Link-Belt Co. Dept. CAMGL-61 "LINK-BELT"
E. F. March Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Ore Reclamation Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
W. J. Savage Co.
Smith Engineering Works
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Road Machinery Co. "RELIANCE"
Watt Car & Wheel Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

BUCKETS, DRAGLINE

Bucyrus-Erie Co.
ESCO CORP.—"TRIPLE TAPERED"
Hendrix Mfg. Co.
McDowell Co. Inc.—"WILLIAMS"
Page Engineering Co.—"AUTO-MATIC"
"Quick-Way" Truck Shovel Co.
Schield Bantam Co.
Taylor-Wharton Co., Div. Harsco Corp.

BUCKETS, DRAGLINE—ARCHES, CHAINS, FITTINGS

Bucyrus-Erie Co.
ESCO CORP.
Hendrix Mfg. Co.
Page Engineering Co.

BUCKETS, DRILL-DUST

Mine Safety Appliances Co.—"DRIL-DUST"

BUCKETS, DUMP

Salem-Brosius, Inc.

BUGDUSTERS, AUTOMATIC

Goodman Mfg. Co.
Joy Mfg. Co.

BUILDING WIRE, CABLE

Rome Cable, Div. of Alcoa

BUILDINGS, PRE-ENGINEERED, PREFAB

Armco Drainage & Metal Prod., Inc.
The Parkersburg Rig & Reel Co., Div. of Parkersburg-Aetna Corp.
Republic Steel—"TRUSCON"
Steel-Bilt Construction Co.
G. C. Thomas Mfg. Co.

BULLDOZER CORNER TEETH

H & L Tooth Co.

BULLDOZER CORNER BITS

American Manganese Steel Div., American Brake Shoe Co.
Caterpiller Tractor Co.
Kensington Steel, Div. of Poor & Co.

BULLDOZER & GRADER BLADES

Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Colorado Fuel & Iron Corp.—"C F & I"
ESCO Corp.—"ESCO"
Gar Wood Industries, Inc.
International Harvester Co.
Letourneau-Westinghouse Co.

BULLDOZER RIPPER TEETH

American Manganese Steel Div., American Brake Shoe Co.

BULLDOZERS

Allis-Chalmers Mfg. Co.
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
J. I. Case Co.—"ASE" (angling)
Caterpiller Tractor Co.
Clark Equipment Co., Construction Machinery Div.
The Eimco Corp.
Frank G. Hough Co. (rubber-tires)
International Harvester Co.
LeTourneau-Westinghouse Co.—"TOURNA-TRACTOR"
Oliver Corp.

BULLETIN-BOARD SERVICE

Elliott Service Co., Inc.

BUMPERS, LOCOMOTIVE

Kanawha Mfg. Co.
Leman Machine Co.
West Virginia Armature Co.

BUMPERS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Sanford-Day Corp.
Watt Car & Wheel Co.
West Virginia Armature Co.

BUMPERS, RUBBER

Continental Rubber Works
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated

BURS, ROTARY

Martindale Electric Co.

BUS, METAL-ENCLOSED, OPEN

Delta-Star Electric Div., H. K. Porter Co., Inc.

BUS BAR, ALUMINUM

Aluminum Co. of America
Reynolds Metals Co.

BUS & CABLE SUPPORT

Delta-Star Electric Div., H. K. Porter Co., Inc.

BUSES, ELECTRIC

I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

BUSHINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO"
Bearings, Inc.
Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co. —"FRICTION FIGHTER"
Imperial-Cantrell Mfg. Co.—"IC"
Jeffrey Mfg. Co.
Kelley Manufacturing Co., Machine Parts Div.
Keystone Carbon Co.
McLanahan Corp.
Penn Machine Co.
Bertrand P. Tracy Co.
Walworth Co.

BUSHINGS, ELECTRICAL

Imperial-Cantrell Mfg. Co.—"IC"
National Electric Div. H. K. Porter Co., Inc.

BUSHINGS, ELECTRICAL, HIGH-VOLTAGE

Ohio Brass Co.

BUSHINGS, IRON

Keystone Carbon Co.

BUSHINGS, RUBBER

United States Rubber Co.

CABLE, ARMORED, FITTINGS FOR

PLM Products, Inc.

CABLE, ASBESTOS-INSULATED, COVERED

American Steel & Wire Div., United States Steel Corp.—"AMERBESTOS"
Collyer Insulated Wire Co.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Cable Corp.
General Electric Co., Wire and Cable Dept.
National Electric Div., H. K. Porter Co., Inc.—"NEASBESTUS"
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Wire & Cable Co., Div. of Cerro Corp. "ROCKBESTOS A.V.C."
Triangle Conduit & Cable Co. Inc.

CABLE, BOREHOLE, NONMETALLIC-SHEATHED

American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Ensign Electric & Mfg. Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
National Electric Div., H. K. Porter Co., Inc.—"NEPCOZONE"
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.
Rome Cable Div. of Alcoa
Simplex Wire & Cable Co.

CABLE, DISTRIBUTION, NONMETALLIC-SHEATHED, ALL VOLTAGES

Aluminum Company of America
American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co.—"ANKOSEAL"
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Flood City Brass & Electric Co.
General Table Corp. — "BUTARONE," "AQUASEAL," "THERMAX-W," "SUPER-SHEATH," "GUARDIAN," "ROMEX," "SUPERTEL"
General Electric Co., Wire and Cable Dept.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Electric Div., H. K. Porter Co., Inc.—"NEPCOZONE"
Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.
Rome Cable, Div. of Alcoa
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co. Inc.
Western Insulated Wire Co. (neoprene)—"BRONCO 66"

CABLE, FEEDER, BARE

Aluminum Company of America
American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.
Rome Cable, Div. of Alcoa
Triangle Conduit & Cable Co. Inc.

CABLE, INSULATED COMMUNICATION, CONTROL, SIGNAL SERVICES

American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co.—"ANKOSEAL"
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
General Cable Corp.
General Electric Co., Wire and Cable Dept.
Kaiser Aluminum & Chemical Sales, Inc.
National Electric Div., H. K. Porter Co., Inc.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Wire & Cable Co., Div. of Cerro Corp.—"ROCKBESTOS P.N.R."
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Rome Cable, Div. of Alcoa
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co. Inc.
Western Insulated Wire Co. (neoprene)—"BRONCO 66"

CABLE LUGS, ELECTRICAL

Erico Products, Inc. — "CADWELD"

CABLE, METALLIC-ARMORED, BOREHOLE AND DISTRIBUTION

General Cable Corp.
Kaiser Aluminum and Chemical Sales, Inc.
National Electric Div., H. K. Porter Co., Inc.—"NEPCOLOK"
Rockbestos Wire & Cable Co., Div. of Cerro Corp.
Simplex Wire & Cable Co. — "CONDEX," "C-L-X CONTINUOUS IMPERVIOUS"

CABLE, MOTOR LEADS, SILICONE-RUBBER INSULATED, ASBESTOS OR FIBERGLASS COVERED

Rockbestos Wire & Cable Co., Div. of Cerro Corp.

CABLE, SHOTFIRING—See also "Wire, shotfiring"

American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
E. I. du Pont de Nemours & Co., Inc.
General Cable Corp.
General Electric Co., Wire and Cable Dept.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosive Operations, Energy Div.
Phelps Dodge Copper Products Co.
Rome Cable, Div. of Alcoa
Simplex Wire & Cable Co.
Trojan Powder Co.

CABLE, SUBMARINE

American Steel & Wire Div., U. S. Steel Corp.—"AMARINE"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co.—"ANKOSEAL"
General Cable Corp.
General Electric Co., Wire and Cable Dept.
Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
Phelps Dodge Copper Products Co.
Slimplex Wire & Cable Co.

CABLE, THERMOPLASTIC & ASBESTOS INSULATED POWER & CONTROL, ASBESTOS-COVERED

Rockbestos Wire & Cable Co.

CABLE, TRAILING, ALL VOLTAGES

Aluminum Co. of America
American Steel & Wire Div., U. S. Steel Corp.—"AMERCLAD"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co.—"ANKOSEAL"
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Flood City Brass & Electric Co.
General Cable Corp.—"SUPER-SERVICE" "TIP TOP," "PEERLESS"
General Electric Co., Wire and Cable Dept.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
National Electric Div., H. K. Porter Co., Inc.
Reynolds Metals Co.
Rome Cable, Div. of Alcoa—"Rome 60"
Salem Tool Co.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co., Inc.
Western Insulated Wire Co. (neoprene)—"BRONCO 66"

CABLE, TRAILING, SHOCK ABSORBERS FOR
Mosebach Electric & Supply Co.

CABLE ACCESSORIES, HIGH VOLTAGE
G & W Electric Specialty Co.
Ohio Brass Co.

CABLE CLAMPS
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Holub Industries, Inc.
Ohio Brass Co.
Rome Cable, Div. of Alcoa

CABLE CONNECTORS, ELECTRICAL
Albert & J. M. Anderson Mfg. Co. —"EITHEREND"
Burndy Corp.—"SERVIT," "QIKLUG," "OKLIP," "KALUG," "SCRULUG," "HYLUG," "HYLINK"
Delta-Star Electric Div., H. K. Porter Co., Inc.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Erico Products, Inc. — "CADWELD"
Ensign Electric & Mfg. Co.
Brad Harrison Co.
Joy Mfg. Co.
Mining Machine Parts, Inc. — "MMP-JABCO"
Mosebach Electric & Supply Co.
National Electric Div., H. K. Porter Co., Inc.
Ohio Brass Co.
Tweco Products, Inc.—"SOLCON," "MECON"
West Virginia Armature Co.

CABLE COUPLERS
Brad Harrison Co.
PLM Products, Inc. (7,500 V)

CABLE FAULT-FINDERS, PROOF TESTERS
The Electrical Distributors Co.
General Equipment & Manufacturing Co.

CABLE HANGERS
American Mine Supply Co.
Ohio Brass Co.
Rome Cable, Div. of Alcoa

CABLE, HEATING, LEAD SHEATHED
Rockbestos Wire & Cable Co., Inc. Div. of Cerro Corp.

CABLE REELS, LOCOMOTIVE
Jeffrey Mfg. Co.
West Virginia Armature Co.

CABLE REELS, MINING-MACHINE, SHUTTLE CAR
Dooley Brothers
Jeffrey Mfg. Co.

CABLE REELS, SHOTFIRING
J. V. Hammond Co.

CABLE-REPAIR SERVICE
Cable Vulcanizing Shop, Inc.
Fadlevich Cable Vulcanizing Shop, Inc.
Fairview Bit Co.
National Mine Service Co.

CABLE SPACERS
PLM Products, Inc.—"HIGH ALUMINA"

CABLE SPLICERS
American Mine Door Co.— "QUICK-ON"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Ensign Electric & Mfg. Co.
Erico Products, Inc. — "CADWELD"
Flood City Brass & Electric Co.
G & W Electric Specialty Co.
Mine Safety Appliances Co.— "VELOCITY-POWER"
Mining Machine Parts, Inc.— "MMP-JABCO"
Minnesota Mining & Mfg. Co.— "SCOTCHCAST"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Tweco Products, Inc.—"TWECO"
West Virginia Armature Co.

CABLE-SPLICING KITS
PLM Products, Inc.

CABLE SUPPORTS, BOREHOLE
Ohio Brass Co.

CABLE SUPPORTS, HORIZONTAL RUNS
The Elreco Corp.—"ELRECO"
Ohio Brass Co.
Rome Cable, Div. of Alcoa

CABLE VULCANIZERS
Flood City Brass & Electric Co.
Joy Mfg. Co.
Pasadena Hydraulics, Inc., "CABLE SAVER"

CAGERS, CAGING EQUIPMENT
C. S. Card Iron Works
Connellsville Corp.
Holmes Bros., Inc.
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.

CAGES, ELEVATOR-TYPE
Connellsville Corp.—"PORTAL-CAGE"
Helmick Foundry-Machine Co.
Holmes Bros., Inc.
Vulcan Iron Works Co. (Denver)

CAGES
C. S. Card Iron Works
Connellsville Corp.
Helmick Foundry-Machine Co.
Holmes Bros., Inc.
Kanawha Mfg. Co.
Mayo Tunnel & Mine Equipment
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.

CALCIUM CHLORIDE
Allied Chemical Corp., Solvay Process Div.
Columbia-Southern Chemical Corp.
The Dow Chemical Co.—"DOWFLAKE," "PELADOW"
Fisher Scientific Co.
Fuel Process Co. (Inc.)— "FUPROCO"
Wyandotte Chemicals Corp., Michigan Alkali Div.

CAPACITORS
General Electric Co., Apparatus Sales Div.
Ohio Brass Co.—"VAREX"
Westinghouse Electric Corp.

CAP HATS
Mine Safety Appliances Co.— "FIXED CROWN"

CAP-LAMP CHARGERS
Mine Safety Appliances Co.
National Mine Service Co.— "WHEAT"

CAP-LAMP RACKS
Mine Safety Appliances Co.
National Mine Service Co.— "WHEAT"

CAP LAMPS
Mine Safety Appliances Co. — "EDISON R4," "EDISON MODEL S"
National Mine Service Co. — "WHEAT"

CAPS, MINERS
E. D. Bullard Co.

CAR BY-PASSERS
American Mine Door Co.—"CANTON"

CAR DUMPERS, MINE
Link-Belt Co., Dept. CAMGL-61— "LINK-BELT"

CAR DUMPERS, R. R. ROTARY
Differential Steel Car Co.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61— "LINK-BELT"
Roberts & Schaefer Company, Division of Thompson-Starrett Co. Inc.

CAR HAULS, MOVERS, PULLERS, R. R.
The Aldon Co.
Advance Car Mover Co., Inc.— "BADGER," "NEW BADGER," "POWER KING," "POWER BOY"

AE Industrial Div., Aircraft Armaments, Inc.—"LO-HED"
Clyde Iron Works, Inc.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins Incorporated—"JONES"
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
Shepard Niles Crane & Hoist Corp.
Webster Mfg. Inc.
Whiting Corp.

CAR HAULS, MOVERS, SPOTTERS, MINE

The Aldon Co.
Connellsville Corp., "SPRAGGERS"
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT"
Morse Bros. Machinery Co.
The Nolan Co.
Sanford-Day Corp.
Schroeder Brothers Corp.
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
W. R. Stamler Corp.
Webster Mfg. Inc.
Wilmot Engineering Co.

CAR HOLDS, STOPS, MINE

C. S. Card Iron Works
Connellsville Corp.
Duquesne Mine Supply Co.
Holmes Bros., Inc.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
The Nolan Co.

CAR LOADERS

Link-Belt Co., Dept. CAMGL-61

CAR-LOADING STATIONS, MINE-CAR AUTOMATIC

W. R. Stamler Corp.

CAR-LOADING STATIONS, R. R., AUTOMATIC

The Nolan Co.

CAR MOVERS

Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE," "NEW RICHTAL," "NEW SUPERIOR"
Link-Belt Co., Dept. CAMGL-61

CAR REBUILDING & REPAIRING

American Car & Foundry Div., ACF Industries, Inc.

CAR PARTS, REPLACEMENTS

American Car & Foundry Div ACF Industries, Inc.

CAR RETARDERS, MINE CAR

American Brake Shoe Co., Railroad Products Div.
Connellsville Corp.
Galis Electric & Machine Co.
Holmes Bros., Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT"
The Nolan Co.
Sanford-Day Corp.
Webster Mfg. Inc.

CAR RETARDERS, R. R.

Holmes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Union Switch & Signal, Div. of Westinghouse Air Brake Co. (electro-pneumatic)
Webster Mfg. Inc.

CAR SHAKERS, R. R.

Allis-Chalmers Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT"
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.—"CARQUAKE"
Webster Mfg. Inc.

CAR STOPS

The Aldon Co.
Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE"
The Nolan Co.

CAR STOPS, ELECTRIC

Cheatham Elec. Switching Device Co.
General Equipment & Manufacturing Co.

CAR THAWERS

American Conveyor Co.—"MR. HOT"
Hauck Mfg. Co.
Hewitt-Robins Incorporated

CAR TRANSFERS, MINE

American Mine Door Co.—"CANTON"
C. S. Card Iron Works
Connellsville Corp.

CAR-UNLOADING VIBRATORS

Cleveland Vibrator Co.
National Air Vibrator Co.

CARBIDE METALS, SINTERED

Allegheny Ludlum Steel Corp.—"CARMET"

CARBON BLACK

Fisher Scientific Co.
R. T. Vanderbilt Co. Inc.

CARRIERS, MINE EQUIPMENT

Enterprise Wheel & Car Corp.
Irwin-Sensenich Corp.
Motor Exchange and Supply Co.

CARRIERS, SHUTTLE-CAR

Salem-Brosius, Inc.—"PHIL-DOLLY"

CARS, BALLAST

Bethlehem Steel Co.
Differential Steel Car Co.

CARS, RAIL, MAN TRIP

C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Holmes Bros., Inc.
Irwin-Sensenich Corp.—"MAN VAN"
Sanford-Day Corp.
Watt Car & Wheel Co.

CARS, RAIL, MAN-TRIP, SELF-PROPELLED

Galis Electric & Machine Co.
Lee-Norse Co.—"MINE PORTAL BUS"

CARS, RAIL, MINE

American Car & Foundry Div. ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin-Sensenich Corp.
Kersey Manufacturing Co., Inc.
Mayo Tunnel & Mine Equipment
Morse Bros. Machinery Co.
Sanford-Day Corp.
United States Steel Corp.
Watt Car & Wheel Co.

CARS, RAIL, PERSONNEL, SELF-PROPELLED

Galis Electric & Machine Co.
Irwin-Sensenich Corp.
Kersey Manufacturing Co., Inc.
Lee-Norse Co.—"MINE JITNEY & MINE SCOOTER," "MINE MECHANIC JITNEY"

CARS, RAIL, TIMBER

Vulcan Iron Works, Inc.

CARS, RAIL, SUPPLY

American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co. "GEMCO TRU-BLUE"
Helmick Foundry-Machine Co.
Holmes Bros., Inc.
Irwin-Sensenich Corp.
Kersey Mfg. Co., Inc.
Sanford-Day Corp.
Watt Car & Wheel Co.

CARS, RAIL, TOOL

Gibraltar Equipment & Mfg. Co.
Kersey Mfg. Co., Inc.

CARS, RUBBER-TIRED, COAL, SELF-PROPELLED

Prime Mover Co.—"M30 PRIME-MOVER"

CARS, RUBBER-TIRED, MEN & SUPPLIES, SELF-PROPELLED

Fred's Welding Service
Gibraltar Equipment & Mfg. Co.
Lee-Norse Co.—"LEE-NORSE UTILITY TRUCK"
Prime Mover Co.—"M30 PRIME MOVER"

CARS, RUBBER-TIRED TRAILING, COAL

Fred's Welding Service
Goodman Mfg. Co.
Kersey Manufacturing Co., Inc.
Motor Exchange and Supply Co.

CARS, RUBBER-TIRED TRAILING, MEN & SUPPLIES

Kersey Manufacturing Co., Inc.

CARS, SHUTTLE

Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kersey Manufacturing Co., Inc.
Morse Bros. Machinery Co.
Motor Exchange and Supply Co.
National Mine Service Co.—"TORKAR"

CARS, SHUTTLE, CRAWLER-TYPE

Myers-Whaley Co.—"WHALEY TRANSFER CAR"

CARS, SHUTTLE, DIESEL

Joy Mfg. Co.

CARS, SHUTTLE, REPAIR OF

Leman Machine Co.

CARTRIDGES, CYLINDRICAL AND FLANGE BALL-BEARING

Bearings, Inc.
Link-Belt Co., Dept. CAMGL-61

CASTINGS, ABRASION-RESISTANT

Bethlehem Steel Co.
Farrell-Cheek Steel Co.
Wall Colomonoy Corp.

CASTINGS, ALLOY

Bethlehem Steel Co.
Coast Metals, Inc.
Farrell-Cheek Steel Co.

CASTINGS, BRASS

Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co.

CASTINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co.

CASTINGS, CENTRIFUGAL, NONFERROUS

Stoody Co.

CASTINGS, CHILLED, HEAT-RESISTING & REPLACEMENT

American Car & Foundry Div., ACF Industries, Inc.

CASTINGS, COPPER

American Brake Shoe Co., National Bearing Div.

CASTINGS, DUCTILE

R. H. Sheppard Co., Inc.

CASTINGS, GRAY IRON

Bethlehem Steel Co.
Link-Belt Co., Dept. CAMGL-61
R. H. Sheppard Co., Inc.

CASTINGS, HEAT-, CORROSION- & ABRASION-RESISTANT

Bethlehem Steel Co.
ESCO Corp.

CASTINGS, IRON, MEEHANITE, MODULAR AND STEEL

Bethlehem Steel Co.

CASTINGS, MALLEABLE IRON

Link-Belt Co., Dept CAMGL-61

CASTINGS, MANGANESE STEEL

Bethlehem Steel Co.
Farrell-Cheek Steel Co.
Kensington Steel, Div. of Poor & Co.

CASTINGS, NON-FERROUS

American Crucible Products Co.

CASTINGS, STEEL

Bethlehem Steel Co.
The Falk Corp.—"MOLLY-TELASTIC"
Farrell-Cheek Steel Co.
Sterling Steel Castings Co.

CAUSTIC SODA

American Minechem Co.
Columbia-Southern Chemical Corp.
The Dow Chemical Co.
Fisher Scientific Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

CEMENT HIGH-TEMPERATURE

Philip Carey Mfg. Co.—"MW-50," "MW-ONE"
Joseph Dixon Crucible Co.
Johns-Manville—"BLAKITE"
Kaiser Refractories and Chemicals Div., Kaiser Aluminum & Chemical Corp.—"BONDSET," "HILOSET," "HY-SET"
Norton Co.—"ALUNDUM," "CRYSTOLON" "MAGNORITE"

CERAMIC COATINGS

Norton Co.—"ROKIDE"

CHAIN CONVEYOR & ELEVATOR

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Chain Div., American Chain & Cable Co., Inc.
Chain Belt Co.—"REX"
Diamond Chain Co., Inc.
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
The Daniels Co.
Farrell-Cheek Steel Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel Div., of Poor & Co.
Link-Belt Co., Dept. CAMGL-61 —"LINK-BELT," "RIVETLESS," "PROMAL," "LXS," "FR," "RC," "SS"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Ore Reclamation Co.
K. Prins & Associates
W. J. Savage Co.
Taylor-Wharton Co. Div. Harsco Corp.
Transall, Inc.
Watt Car & Wheel Co.
Webster Mfg. Inc.
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
Wilmot Engineering Co.

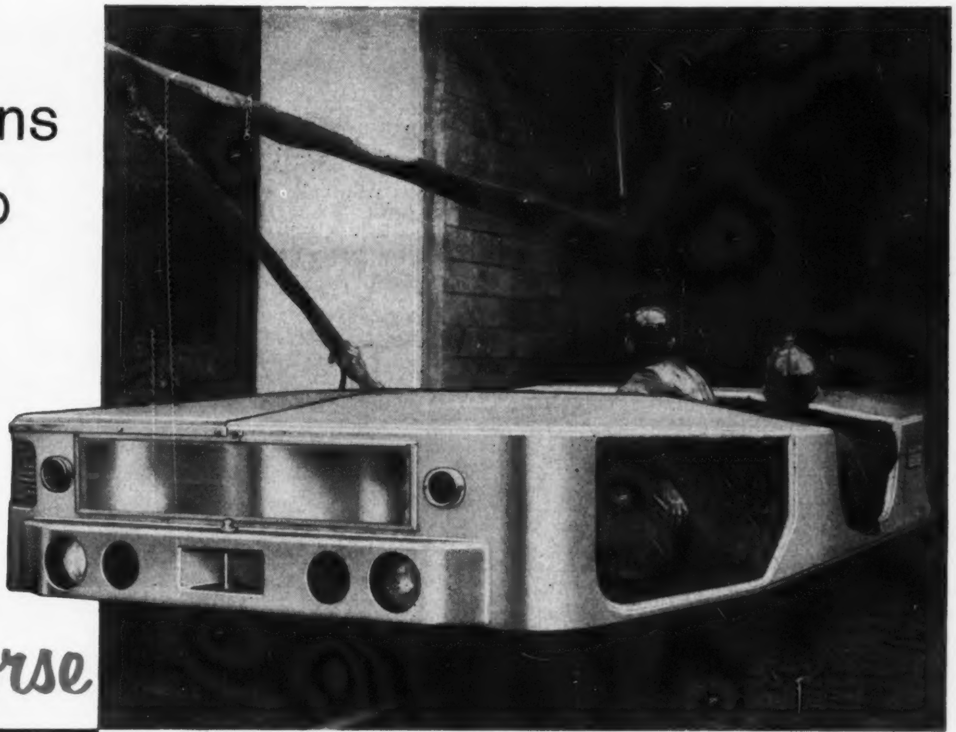
CHAIN, MINE CAR SAFETY

American Chain Div., American Chain & Cable Co., Inc.

CHAIN POWER-TRANSMISSION

American Chain Div., American Chain & Cable Co., Inc.
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT," "LXS," "RC," "SS," "PROMAL," "RIVETLESS"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Morse Chain Co., A Borg-Warner Industry
Transall, Inc.
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

Reasons why so many mines use the *Lee-Norse*



LOW mine portal bus

(1) FAST—Cuts portal to portal time as much as 50%.

(2) STREAMLINED—Transports 11 to 13 men in safety and comfort in low seams.

(3) SAFETY—Exclusive split-roof allows operator full directional vision—trolley pole easily reached. Quick acting hydraulic truck-type brakes on each axle and on the traction gearmotor. Independent mechanical hand parking brake each axle.

(4) POWERFUL—Self-propelled by sturdy traction-type 15 HP gearmotor (250 or 550V—DC).

(5) RUGGED—Quality built to withstand the hard usage of 'round the clock mining!

(6) LOW MAINTENANCE—Simple design—easy accessibility.

(7) OPTIONAL FEATURE—Electric dynamic brakes for plus safety on severe grades.

LN

Lee-Norse Company

CHARLEROI, PENNSYLVANIA

Specialists in Coal Mining Equipment

CHAIN REPAIR LINKS
Link-Belt Co., Dept. CAMGL-61
Page Engineering Co.—"TWIN-FIN," "KWIK-WELD"

CHAIN, ROLLER
Acme Chain Corp.
Dodge Mfg. Corp.
Flood City Brass & Electric Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co.
Link-Belt Co., Dept. CAMGL-61—"FR," "RC" "SILVER-BRITE," "DOUBLE-PITCH," "SHOT-PEENED"
The Whitney Chain Co., a Sub. of Foote Bros. Gear & Machine Corp.

CHAIN, SHUTTLE CAR
Duquesne Mine Supply Co.
Link-Belt Co., Dept. CAMGL-61
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

CHAIN, SILENT
Link-Belt Co., Dept. CAMGL-61—"SILVERSTREAK"

CHAIN, WELDED
American Chain Div., American Chain & Cable Co., Inc.
Columbus McKinnon Corp., Mining Equipment Div.—"HERC-ALLOY"
Page Engineering Co.

CHAIN, WELDLESS
American Chain Div., American Chain & Cable Co., Inc.

CHAIN FITTINGS
American Chain Div., American Chain & Cable Co., Inc.
Columbus McKinnon Corp., Mining Equipment Div.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY—LAUGHLIN"
ESCO Corp.
Farrell-Cheek Steel Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Page Engineering Co.
Taylor-Wharton Co. Div., Harsco Corp.

CHAIRS, CAGE-LANDING
The Nolan Co.
Vulcan Iron Works Co. (Denver)

CHOCKS, WHEEL, SAFETY
The Aldon Co.

CHUTE LININGS
Paltech Co.

CHUTES
The Daniels Co.
Enterprise Wheel and Car Corp.
Galis Electric & Machine Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Koven Fabricators, Inc.
Link-Belt Co., Dept. CAMGL-61
Lippman Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Ore Reclamation Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Co. Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Templeton-Matthews Corp.
G. C. Thomas Mfg. Co.
Transall Inc.
Wilmot Engineering Co.

CHUTES, DIVERSION, COAL LOADING
The Daniels Co.
Galis Electric & Machine Co.
Helmick Foundry-Machine Co.
Holmes Bros., Inc.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
Schroeder Brothers Corp.
G. C. Thomas Mfg. Co.
Wilmot Engineering Co.

CIRCUIT-BREAKER ENCLOSURES
General Electric Co., Apparatus Sales Div.

CIRCUIT BREAKERS
Cutler-Hammer, Inc.—"Safety-breaker"

CIRCUIT BREAKERS, AIR
Allis-Chalmers Mfg. Co.—"RUP-TAIR"
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
National Mine Service Co.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, OIL
Allis-Chalmers Mfg. Co.
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, MOLDED-CASE
Circuit Protective Devices Dept., General Electric Co.

CIRCUIT INTERRUPTORS, TRAILING CABLE
Joy Mfg. Co.
Ohio Brass Co.—"MAGNATRIP"

CLAMPS
B. F. Goodrich Industrial Products Co.—"PUNCHLOK"

CLAMPS, FUSE
Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Holub Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

CLAMSHELLS
ESCO Corp.
Koehring Div. of Koehring Co.
The Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

CLARIFIERS
The Eimco Corp.
Heyl & Patterson, Inc.
Infilco Incorporated, Gale Separator Div.—"SEDIFLOTOR"
Link-Belt Co., Dept. CAMGL-61

CLASSIFIERS, AIR
Buell Engineering Co., Inc.

CLASSIFIERS, HYDRAULIC
Bird Machine Co.—"BIRD"
Nelson L. Davis Co.—"NELDCO"
The Deister Concentrator Co., Inc.—"CONCENCO"
Deister Machine Co.
Denver Equipment Co.—"DEN-VER"
Dorr-Oliver, Incorporated
Heyl & Patterson, Inc.
Kennedy Van Saun Mfg. & Eng. Corp.
Link-Belt Co., Dept. CAMGL-61
Smith Engineering Works
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.—"HYDROTATOR"
WEMCO Div., Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

CLASSIFIERS, MECHANICAL
Buell Engineering Co., Inc.
Denver Equipment Co.—"DEN-VER"
Dorr-Oliver, Incorporated
Eagle Iron Works
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61
Mine and Smelter Supply Co.—"AKINS"
Morse Bros. Machinery Co.—"TRUELINE"
Straub Mfg. Co., Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"

CLEANERS, AIR, FOR COAL—See AIR CLEANERS, COAL

CLEANERS, MOTOR
American Minechem Co.—"ELMO," "MACMO"

CLEANERS, STEAM
Clayton Mfg. Co.—"CLAYTON"
Homestead Valve Mfg. Co., "HY-PRESSURE JENNYR"
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

CLEANING COMPOUNDS, STEAM CLEANING
Homestead Valve Mfg. Co., "HY-PRESSURE JENNYR"

CLOTHING, PROTECTIVE
American Optical Co., Safety Products Div.
B. F. Goodrich Industrial Products Co.
Pulmosan Safety Equip. Co.

CLUTCH FACINGS
Raybestos Manhattan Inc., Manhattan Rubber Div.
S. K. Wellman Co.—"VELVE-TOUCH FERAMIC," "VELVE-TOUCH CERAMIC"

CLUTCHES
Morse Chain Co., A Borg-Warner Industry—"ROCKFORD" over-center, "PULMORE" multiple-disc

CLUTCHES, AIR
Dodge Mfg. Corp.—"AIRGRIP"

CLUTCHES, AIR-ACTUATED, OIL-ACTUATED
Twin Disc Clutch Co.

CLUTCHES, AUTOMATIC
Hewitt-Robbins Incorporated
Marland One-Way Clutch Co.
Twin Disc Clutch Co.

CLUTCHES, ELECTRIC
I-T-E Circuit Breaker Co.
Twin Disc Clutch Co.

CLUTCHES, FRICTION
Dodge Mfg. Corp.—"DIAMOND D," "ROLLING GRIP"
Eaton Mfg. Co., Dynamatic Div.—"DYNATORQ"
Joy Mfg. Co.
Link-Belt Co., Dept., CAMGL-61
Morse Chain Co., A Borg-Warner Industry — "TORQUE LIMITERS"
Twin Disc Clutch Co.

CLUTCHES, JAW
Link-Belt Co., Dept. CAMGL-61

CLUTCHES, MAGNETIC
Cutler-Hammer Inc.
Eaton Mfg. Co., Dynamatic Div.—"DYNATORQ"

CLUTCHES, OVERRUNNING
Marland One-Way Clutch Co.
Morse Chain Co., A Borg-Warner Industry
Joy Mfg. Co.

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Commercial Testing & Engineering
Holmes Bros., Inc.
Warner Laboratories, Inc.

COAL BLENDING SYSTEMS
B-I-F Industries, Inc.
Link-Belt Co., Dept. CAMGL-61

COAL BREAKERS, AIR
Long-Airdox Co.
Olin-Mathieson Chemical Corp., Explosive Operations, Energy Div.—"ARMSTRONG"

COAL BREAKERS, CO_2, CHEMICAL
Long-Airdox Co.

COAL-CARBONIZATION ASSAYS
Fuel Research & Instrument Co.

COAL, CLEANERS See AIR CLEANERS, COAL

COAL INSPECTION, SAMPLING
ommercial Testing & Engineering Co.
'arner Laboratories, Inc.

COAL-TEST OVENS, EXPANSION-CONTRACTION, SOLE-HEATED
Fuel Research & Instrument Co.

COAL STORAGE—See storage and reclaiming systems

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Johns-Manville—"ASBESTILE," "AQUADAM," "REGAL"
Pittsburgh Plate Glass Co.—"PITTSBURGH"
The Ruberoid Co.
Stonhard Co. Inc.
Warren Refining & Chemical Co.—"STORM KING," "STORM KING PLUS" "STORM KING ALUMINUM"

COATINGS, CAST PIPE
Goodyear Tire & Rubber Co.
Stonhard Co. Inc.

COATINGS, CERAMIC
The Galighor Co.—"ROKIDE"®

COATINGS, DAMPROOFING
Philip Carey Mfg. Co.—"FOUNDATION COATING"

COATINGS, ELECTRICAL
Minnesota Mining & Mfg. Co.—"IVI-SPRAY" BRAND, "IR-VINGTON" BRAND, "SCOTCH-BRAND KOTE"

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Rust-Oleum Corp.—"RUST-OLEUM"

COATINGS, INSULATING, ROOF & SIDING
The Wilbur & Williams Co., Inc.

COATINGS, MINE ROOF RIBS, PERMANENT STOPPINGS
American Minechem Co.—"ROOFSKIN" "STOPPER-SKIN"
Stonhard Co. Inc.

COATINGS, PROTECTIVE
Amercoat Corp.—"AMERCOAT," "DIMETCOAT" "ZINKOTE"
American Minechem Co.
American Oil Co.
Ashland Oil & Refining Co.—"VALVOLINE—ASHLAND TECTYL"
Philip Carey Mfg. Co. "MASTIC," "SEMI-MASTIC," "SUPER EBONTEX"
Cities Service Oil Co.
Joseph Dixon Crucible Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Esso Standard, Div. of Humble Oil and Refining Co.—"RUSTBAN"
B. F. Goodrich Chemical Co.—"GEON"
Johns-Manville— "INSULKOTE"
Keystone Lubricating Co.
Magichemical Co.—"MAGI-VULC"
Master Bronze Powder Co., Inc. — "DERUSTO," "DERUSTO MINIT FINISH," "DERUSTO galv-a-grip," "DERUSTO Hi-Heat Finishes," "DERUSTO Chemical-Resistant Finishes"
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Pittsburgh Plate Glass Co.—"PITTSBURGH"
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Shell Oil Co.
Sika Chemical Corp. — "SIKA-SEAL," "SIKA EPOXY SURFACE-KOTE"
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United States Rubber Co.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.—"TECTYL"
Warren Refining & Chemical Co. "WARCO"
The Wilbur & Williams Co., Inc., "TOTRUST," "ZINC SHIELD," "RUBBER LIQUID HY-PALON," "TILE-COTE" Epoxy

COATINGS, R. R.-CAR
American Minechem Co.—"HOP-PERCOAT"

COATINGS, REFRACTORY
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp. — "MEXICAN," "SPRAY MIX," "SUPER MASTIC," "HELSPOT LADLE WASH," "HEKSKOTE"
H. K. Porter Co., Refractories Dept.

Step up tonnage, cut costs, reduce inventories . . . with Sunoco 740-A EP lubricant and Suntac 502, one of the many Sun job-fitted hydraulic oils. Sunoco 740-A EP clings like grease, pours like oil. It is water and heat resistant . . . gives excellent rust and corrosion protection . . . won't thin down under severe service. And it meets all daily underground requirements, except your hydraulic needs. Pioneering of this basic lube program by Sunoco even sparked development, in conjunction with a leading equipment manufacturer, of the well-known two-output pump shown above. It can be used, with a product like 740-A EP, to fill gear cases at high *volume* or on pressure fittings at high *pressure*.

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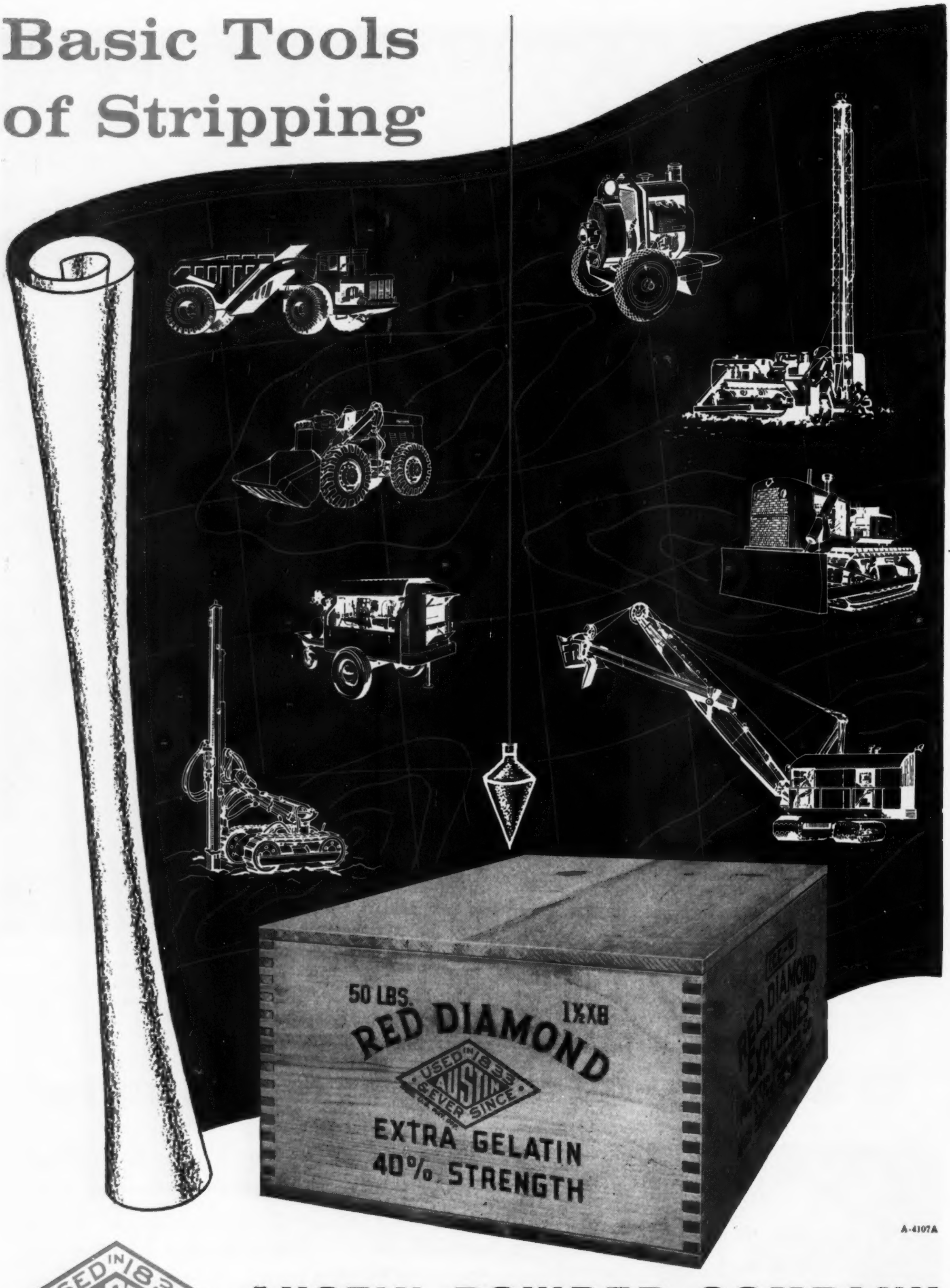
Basic Tools of Stripping



A-4107A

AUSTIN POWDER COMPANY

Cleveland 13, Ohio

explosives ◆ ammonium nitrates ◆ primers ◆ blasting supplies
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Sika Chemical Corp.—"SIKA-KOTE"
Stonhard Co., Inc. — "STON-TITE"

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Martindale Electric Co.

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Jeffrey Mfg. Co.
National Electric Coil Div. of Mc-Graw-Edison Co.
Pennsylvania Electric Coil Corp.
West Virginia Armature Co.
Westinghouse Electric Corp.

COILS, DEMAGNETIZING
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Connellsville Corp.

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Mine Safety Appliances Co.—"MINEPHONE," "HOIST-PHONE
Talk-A-Phone Co.
Union Switch & Signal Div. of Westinghouse Air Brake Co.
Westinghouse Electric Corp.

COMMUNICATIONS, R. R. SIGNAL
Union Switch & Signal Div. of Westinghouse Air Brake Co.

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Valvoline Oil Co., Div. of Ashland Oil & Refining Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

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Columbia-Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Johns-Manville—"HY-SORB"
Wyandotte Chemicals Corp., Michigan Alkali Div.

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General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept.

COMPOUNDS, GENERAL CLEANING
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Martindale Electric Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

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Keystone Lubricating Co.—"VIKE GRAPHITE PLASTIC SEAL," "VIKE WATERSEAL"
Sika Chemical Corp.—"IGAS"

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Stonhard Co., Inc.—"STONTOP"

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Bethlehem Steel Co.
H. K. Porter Co., Conners Steel Div.—"CONNORS"

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Triangle Conduit & Cable Co., Inc

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Flexaust Co.—"PLICA"
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Kaiser Aluminum and Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Electric Products Co.
National Electric Div., H. K. Porter Co.—"SHERARDUCT," "XDUCT" "ECONOMY," "EMT," "FLEX-STEEL," "NE-ALUMINUM"
Republic Steel — "ELECTRU-NITE"
Reynolds Metals Co. (aluminum)
Rome Cable, Div. of Alcoa
Triangle Conduit & Cable Co., Inc.
The Youngstown Sheet and Tube Co.—"BUCKEYE," "YOLOY"

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Crouse-Hinds Co.—"CONDULET"
National Electric Div., H. K. Porter Co., Inc.
Rome Cable, Div. of Alcoa
Triangle Conduit & Cable Co. Inc.
The Youngstown Sheet and Tube Co.

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Hercules Powder Co.
Trojan Powder Co.

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Crouse-Hinds Co.—"ARK-trol"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Brad Harrison Co.
Holub Industries, Inc.
The Lincoln Electric Co.—"Q-D"
Minnesota Mining & Mfg. Co.—"SCOTCHLOK" Brand
National Electric Div., H. K. Porter Co., Inc.
Ohio Brass Co.
Schroeder Brothers Corp.

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Eavenson, Auchmuty & Greenwald

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Keystone Carbon Co.

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Clark Controller Co.
Cutler-Hammer, Inc.
Dooley Brothers
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.
Ohio Carbon Co.
Schroeder Brothers Corp.
Bertrand P. Tracy Co.
Westinghouse Electric Corp.

CONTACTS, ELECTRICAL, REFACED
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CONTAINERS, RUBBER COLLAPSIBLE
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Jeffrey Mfg. Co.—"COLMOL"
Joy Mfg. Co.
Lee-Norse Co.—"LEE NORSE MINER"
National Mine Service Co., Clarkson Div.—"MARIETTA"
Wilcox Mfg. Co.—"WILCOX MINER"

CONTINUOUS MINERS, REPAIR OF
Leaman Machine Co.

CONTINUOUS TUBING, POLYETHYLENE
Bemis Bros. Bag Co.

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McDowell Co. Inc.
Heyl & Patterson, Inc.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co. Inc.
G. C. Thomas Mfg. Co.

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Joy Mfg. Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood

CONTRACTORS, ELECTRICAL-CONSTRUCTION
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.

CONTRACTORS, GROUTING
Cowin & Co., Inc.
Hoffman Bros. Drilling Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood

CONTRACTORS, GUNITING
Cowin & Co., Inc.

CONTRACTORS SHAFT-DRILLING
Pennsylvania Drilling Co.

CONTRACTORS, SHAFT & SLOPE
Cowin & Co., Inc.
The R. G. Johnson Co.

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The Bristol Co.—"BRISTOL's"
Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons—"HANCO"
Hays Corp.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Reliance Electric & Engrg. Co.
Schroeder Brothers Corp.
Bertrand P. Tracy Co.
Westinghouse Electric Corp.

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Cheatham Elec. Switching Device Co.
General Equipment & Manufacturing Co.

CONTROLLERS, ELECTRONIC
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Clark Controller Co.
Cutler-Hammer, Inc.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
General Equipment & Manufacturing Co.
Hays Corp.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Division—"ELECTR-O-PULSE," "ELECTR-O-LINE," "ELECTR-O-VANE," "ELECTR-OVOLT," "PRO-TECT-O-VANE," "VERSA-TRAN," "ELECTRONICK 15," "ELECTRONICK 17"
Reliance Elec. & Eng. Co.

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The Bristol Co.—"DYNA-MASTER"

CONTROLLERS, HYDRAULIC
Industrial Physics & Electronics Co.
Joy Mfg. Co.
Schroeder Brothers Corp.
Vickers Incorporated

CONTROLLERS, LOCOMOTIVE
General Electric Co., Apparatus Sales Div.
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Jeffrey Mfg. Co.
Morse Bros. Machinery Co.

CONTROLLERS, PNEUMATIC
B-I-F Industries, Inc.
The Bristol Co.—"FREEVANE"
A. W. Cash Co.
Farris Flexible Valve Corp.—"FLEX-VALVE," "SUPER SEAL"
Foxboro Co.
Industrial Physics & Electronics Co.
Joy Mfg. Co.
Minneapolis Honeywell Regulator Co., Industrial Division—"AIR-O-LINE," "THROTTLOR," "FULL THROTTLOR"

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West Instrument Corp.—"GARDSMEN"

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Industrial Physics & Electronics Co.

CONTROLS, CABLE-TYPE
Caterpillar Tractor Co.
Rome Cable Corp.

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The Bristol Co.—"META-METER TELEMETER"
Femco Inc.
Industrial Physics & Electronics Co.
Union Switch & Signal Div. of Westinghouse Air Brake Co.
Westinghouse Electric Corp.

CONTROLS, LIQUID LEVEL
Automation Products, Inc.—"DYNATROL"
Megator Corp.—"MEGATOR"

CONTROLS, SOLID-LEVEL
Automation Products, Inc.—"DYNATROL"

CONTROLS, REMOTE AND AUTOMATIC, FOR RAILROADS
Union Switch & Signal, Div. of Westinghouse Air Brake Co.

CONTROLS, REMOTE, LOCOMOTIVE, OFF-TRACK VEHICLES
Union Switch & Signal Div. Westinghouse Air Brake Co.

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Allison Div., General Motors Corp.—"TORQMATIC"

CONVEYOR-BELT CLAMPS
Flexible Steel Lacing Co.—"ALFARPUL"
General Splice Corp.—"MINET"

CONVEYOR-BELT COLD VULCANIZING
Rema-Tech, Inc.

CONVEYOR-BELT CUTTERS
Flexible Steel Lacing Co.—"ALLIGATOR"

CONVEYOR-BELT DRIVE PULLEYS
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Chain Belt Co.—"REX"
J. D. Christian Engineers—"PACKAGED POWER TERMINALS"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"TAPER-LOCK"
Goodman Mfg. Co.
Hewitt-Robins Incorporated
The Homer Mfg. Div., The Ohio Electric Mfg. Co.—"HOMER," "MAGNETIC"
Iowa Mfg. Co.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engrg. Works, Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
W. J. Savage Co.
Transall, Inc.
Webster Mfg. Inc.
West Virginia Belt Repairs, Inc.—"VULCANIZED LAGGING"
T. B. Woods Sons Co.

CONVEYOR-BELT IDLER PULLEYS
The American Pulley Co.
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
The Fafnir Bearing Co.
The Galigher Co.
Goodman Mfg. Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.—"CURVE-CROWN"
Transall, Inc.
Webster Mfg. Inc.
T. B. Woods Sons Co.

CONVEYOR-BELT IDLERS
Barber-Greene Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Farrell-Cheek Steel Co.
The Galigher Co.
Goodman Mfg. Co.
Goodyear Tire & Rubber Co.—"PNEUMATIC"
Hewitt-Robins Incorporated
Industrial Rubber Products Co.
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.—"PERMA-SEAL"
Joy Mfg. Co.—"LIMBEROLLER," "TRULINE"
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"SERIES 5000," "6000," "7000," "8000," "9000." "LINK-BELT"
Lippmann Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
E. F. Marsh Engrg. Co.—"MARCO"
Megator Corp.—"MEGATOR-HANMADE"
Pioneer Engineering, Div. of Poor & Co.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"AUTO-TILT," "MAMMOTH," "SIMPLEX," "SACON," "SUPER SIMPLEX," "JUNIOR SIMPLEX," "PACIFIC"
Transall, Inc.
Webster Mfg. Inc.

CONVEYOR-BELT LOADING STATIONS AUTOMATIC MINE
Link-Belt Co., Dept. CAMGL-61
W. R. Stamler Corp.

CONVEYOR-BELT REPAIR KITS
Automatic Vulcanizers Corp.
Crescent Fastener Co.—"CRESCENT" (Repair Kits)
Magichemical Co.
Rema-Tech, Inc.

CONVEYOR-BELT REPAIR MATERIAL
Automatic Vulcanizers Corp.
Crescent Fastener Co. C Plates & Rivets "CRESCENT"
Peerless Hardware Mfg. Co. "TALCOTT ACME"
Rema-Tech, Inc.

CONVEYOR BELT SPLICING, SHOP & FIELD
West Virginia Belt Repairs, Inc.

CONVEYOR BELT TRIPPERS
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Hewitt-Robins, Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Inc.

CONVEYOR BELTING
Acme-Hamilton Mfg. Corp.—"KING KOAL," "PRYO PRENE," "IDEAL," "NEO-PRENE," "ENDURANCE," "SUPER SERVICE"
American Biltrite Rubber Co. Boston Woven Hose & Rubber Co., Div.—"BOSTON," "BOSTRON"
Bando Rubber Mfg. Co. Ltd.—"SUN," "SPECIAL SUN"
Barber-Greene Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WISSCO"
Continental Conveyor & Equipment Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CARICOAL"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE"
Industrial Rubber Products Co. (W. Va.)
Iowa Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LION," "SERVICE," "FAULTLESS"
Megator Corp.—"MEGATOR-GREENGATE"
National Mine Service Co.—"SCANDURA"
Paltech Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"RECORD-MAKER"
Russell Mfg. Co.—"RUSLON"
W. J. Savage Co.
Scandura, Inc.—"SCANDURA," "GOLD LINE"
Smith Engineering Works
Thermoid Div., H. K. Porter Co., Inc.
Transall, Inc.
United States Rubber Co. "RUSLON P.V.C."

CONVEYOR-BELTING CLEANERS
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Nelson L. Davis Co.—"NELDCO"
Goodyear Tire & Rubber Co.—"STA-KLEEN"
Hewitt-Robins Incorporated
Kanawaha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Stephens-Adamson Mfg. Co.
Transall, Inc.
United States Rubber Co.

CONVEYOR-BELTING FASTENERS, SPLICING MATERIALS
Armstrong, Bray & Co.—"PLATEGRIP," "HINGED "PLATEGRIP"
Automatic Vulcanizers Corp.
Conveyor Belt Service, Inc.
Crescent Fastener Co. (Plates & Rivets)—"CRESCENT"
Flexible Steel Lacing Co.—"FLEXCO," "FLEXCO HINGED," "ALLIGATOR"
B. F. Goodrich Industrial Products Co.
General Splice Corp.—"MINET"
Goodyear Tire & Rubber Co.
National Mine Service Co.—"HAYDEN"
Peerless Hardware Mfg. Co.—"TALCOTT"
Rema-Tech, Inc.
Transall, Inc.
United States Rubber Co.

CONVEYOR BELTING REPAIR SERVICE
Conveyor Belt Service, Inc.
B. F. Goodrich Industrial Products Co.
Reid Belt & Rubber Co. Inc.
West Virginia Belt Repairs, Inc.

CONVEYOR BELTING TIGHTENERS
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

CONVEYOR-BELTING VULCANIZERS
Automatic Vulcanizers Corp.
B. F. Goodrich Industrial Products Co.
Heintz Mfg. Co.
Rema-Tech, Inc.

CONVEYOR COVERS
Armco Drainage & Metal Prod., Inc.
Barber-Greene Co.
Continental Conveyor & Equipment Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
E. F. Marsh Engrg. Co.—"MARCO"
Pioneer Engineering, Div. of Poor & Co.
McNally Pittsburg Mfg. Corp.
G. C. Thomas Mfg. Co.
Transall, Inc.

CONVEYOR LOADERS, UNDERGROUND
The Eimco Corp.

CONVEYOR LOADING CHECKS
Daly Ticket & Printing Co.—"DALY'S"

CONVEYOR PULLEY LAGGING
General Splice Corp.—"MINET," "COLDBOND"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

CONVEYOR WEIGHERS
ABCs Scale Div., McDowell Co., Inc.—"ABC"®
B-I-F Industries, Inc.—"CONVEYELO," "PNEU-WEIGH"
Industrial Physics & Electronics Co.—"CON-O-WEIGH"
Merrick Scale Mfg. Co.—"WEIGHTOMETER"
Thurman Scale Co., Div. Thurman Mfg. Co.

CONVEYORS, APRON
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Galis Electric & Machine Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"AMSCO"
Webster Mfg. Inc.

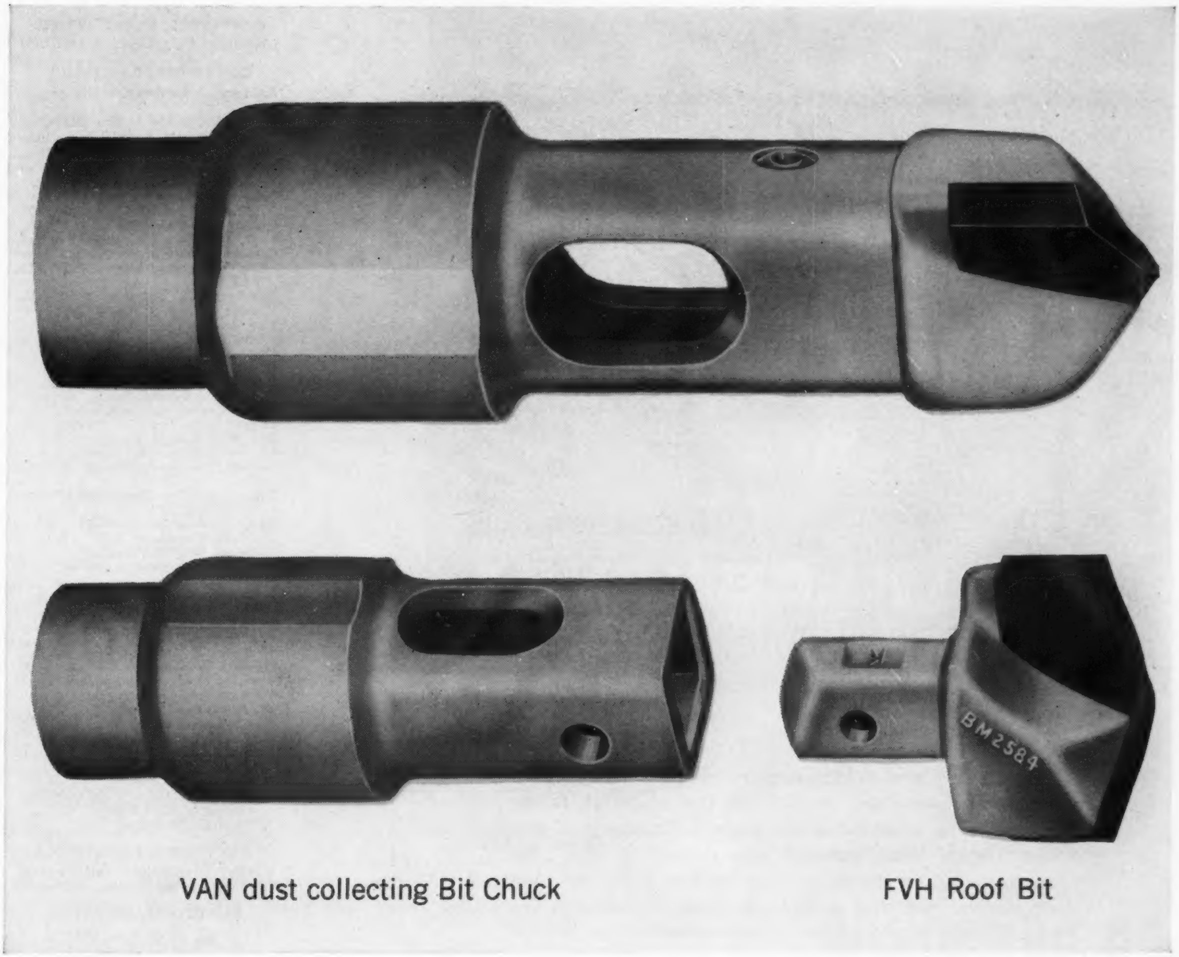
CONVEYORS, APRON, CURVE-GOING
Herold Mfg. Co.
Link-Belt Co., Dept. CAMGL-61

CONVEYORS, APRON, REPAIRS OF
Leman Machine Co.
Link-Belt Co., Dept CAMGL-61

CONVEYORS, BELT
American Conveyor Co.—"CON-VAY-IT," "STOKER-VEYOR"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. "LIMA AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mfg. Co., Inc.—"HI-SPEED"
Carlyle Rubber Co., Inc.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WISSCO"
Continental Conveyor & Equipment Co.
Diamond Iron Works Div.
Galis Electric & Machine Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Herold Mfg. Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
The Homer Mfg. Div., The Ohio Electric Mfg. Co.—"HOMER"
Iowa Mfg. Co.
Irwin Sensenich Corp.
Jeffery Mfg. Co.
Joy Mfg. Co. (& conventional)—"LIMBEROPE," "READY-SPAN"
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-61 "LINK BELT," "PRE-BILT"
Lippmann Engrg. Works Inc.
Long-Airdox Co.
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"ZIPPER"
G. C. Thomas Mfg. Co.
Transall, Inc.
United States Rubber Co.
Universal Road Machinery Co.—"RELIANCE"
Webster Mfg. Inc.

CONVEYORS, BELT, EXTENSIBLE
J. D. Christian Engineers
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated—"MINE-AVEYORS"
Jeffery Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"PRE-BILT"
Long-Airdox Co.—"FULL DIMENSION SYSTEM"
E. F. Marsh Engrg. Co.—"MARCO"
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

CONVEYORS, BUCKET
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Baughman Mfg. Co., Inc.—"HI-SPEED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyors & Equipment Co.
Galis Electric & Machine Co.
The Galligher Co.
Hewitt-Robins Incorporated
Jeffery Mfg. Co.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg Corp.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engrg. Works, Inc.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Webster Mfg. Inc.
Wilmot Engineering Co.



VAN dust collecting Bit Chuck

FVH Roof Bit

NEW Kennametal* FVH Roof Bit and Drill Steel combination provides maximum dust removal without loss of drilling speed

The new Kennametal combination, FVH Roof Bit and internal dust collecting Drill Steels, offers you these outstanding advantages:

Drill steels have heat-treated, prefabricated chucks and shanks that permit the attainment of strong metallurgical properties in these components.

Shorter shank and body of the FVH bit minimize the distance between point of penetration and vacuum slots—assure a smooth, fast flow of cuttings into the hollow steel.

Half-inch square chuck has an integral collar that traps the dust in the slotted section through which the dust is drawn into the hollow drill steel.

Carbide insert has flat bearing surface that gives it more support — which assures greater resistance to breakage and therefore longer bit life.

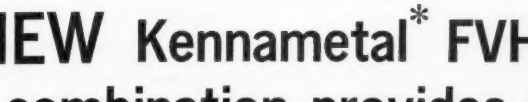
Pin holes are located at right angles to the dust removal slots—so the pin holding the bit cannot obstruct the flow of dust or cuttings.

Varieties of drivers and extensions of similar construction are available for use with the FVH bit.

Approved as Permissible, BM 2584, by the U.S. Bureau of Mines.

For a check on how the superior performance of Kennametal FVH bits and drill steels may help improve production and profits at your mine, call your Kennametal Representative or contact us direct. Kennametal Inc., Mining Tool Division, Bedford, Pennsylvania, Phone 623-5134.

*Trademark



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INDUSTRY AND KENNAMETAL ...Partners in Progress

CONVEYORS, BUCKET-WHEEL

Link-Belt Co., Dept. CAMGL-61

CONVEYORS, CABLE-BELT

National Mine Service Co.

CONVEYORS, CHAIN, CHAIN & FLIGHT

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Conveyor Co.—"FLIGHTVEYOR"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Columbus McKinnon Corp., Mining Equipment Div.—"POWER-FLEX"
Continental Conveyor & Equipment Co.
The Daniels Co.
ESCO Corp.
Galis Electric & Machine Co.
Goodman Mfg. Co.
Helmick Foundry-Machine Co.
Heyl & Patterson, Inc.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div of Poor & Co.
Link-Belt Co., Dept. CAMGL-61 "FLITE-FLO"
Long-Airdox Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Mining Progress, Inc.—"PANZER"
National Mine Service Co., Clarkson Div.—"REDBIRD," "UNIFLIGHT"
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
G. C. Thomas Mfg. Co.
Transall, Inc.
Watt Car & Wheel Co.
Webster Mfg. Inc.
Wilcox Mfg. Co. "WILCOX UNIVERSAL ADVANCE"
Wilmot Engineering Co.

CONVEYORS, DEWATERING

Carrier Div., Chain Belt Co.
Link-Belt Co., Dept. CAMGL-61

CONVEYORS, ELEVATING

Baughman Mfg. Co., Inc.—"HI-SPEED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Galis Electric & Machine Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Irwin Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61 "BULK-FLO," "LINK-BELT" "PRE-BILT"
Lippmann Engrg. Works Inc.
Long-Airdox Co.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Roberts & Schaefer Company Division of Thompson-Starrett Company Inc.
Stephens-Adamson Mfg. Co.—"REDLER," "ZIPPER"
Transall, Inc.
United States Rubber Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, ELEVATING, MINE TRANSFER, CAR LOADING

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

CONVEYORS, EXTENSIBLE CHAIN

Link-Belt Co., Dept. CAMGL-61

CONVEYORS, MINE

Link-Belt Co., Dept. CAMGL-61

CONVEYORS, MINE BRIDGE

Goodman Mfg. Co.
Long-Airdox Co.—"PIGGYBACK"

CONVEYORS, MOBILE HEAD, CHAIN

Long-Airdox Co.

CONVEYORS, OSCILLATING

Link-Belt Co., Dept. CAMGL-61 —"LINK-BELT," "ELE-MOUNT," "COILMOUNT," "TORQMOUNT"
Webster Mfg. Co.

CONVEYORS, PORTABLE

American Conveyor Co.—"CON-VAY-IT"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA AUSTIN WEST-ERN"
Barber-Greene Co.
Baughman Mfg. Co. Inc.—"HI-SPEED"
J. D. Christian Engineers
Goodman Mfg. Co.
Herold Mfg. Co.
Iowa Mfg. Co.
Irwin-Sensenich Corp.
Joy Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pettibone Mulliken Corp., Haiss Div.
Pioneer Engineering, Div. of Poor & Co.
Stephens-Adamson Mfg. Co.

CONVEYORS, ROPE & BUTTON

Galis Electric & Machine Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

CONVEYORS, SCREW

Baughman Mfg. Co., Inc.—"HI-SPEED"
Canton Stoker Corp.—"FLO-TUBE"
Central Mine Equipment Co.—"CME"
J. D. Christian Engineers—"HEVI-EDGE MANGANESE"
Continental Conveyor & Equipment Co.
Dallas Engineers Inc., Coal-O-Matic Div.—"ANTHRA-FLO,"
Dayton Automatic Stoker Co.
Jeffrey Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-61 "QUICK-LINK," "HELICORD," "LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Sprout Waldron & Co., Inc.,
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

CONVEYORS, SELF-LOADING, MINE

Goodman Mfg. Co.
Herold Mfg. Co.
Link-Belt Co., Dept. CAMGL-61

CONVEYORS, SHAKING, MINE

Goodman Mfg. Co.
Herold Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

CONVEYORS, SHAKING, VIBRATING

Carrier Div., Chain Belt Co. "CARRIER NATURAL FREQUENCY"
Galis Electric & Machine Co.—"LECCO-VIB"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61 "LINK-BELT," "FLEX-MOUNT," "COILMOUNT," "TORQMOUNT"
Stephens-Adamson Mfg. Co.
Syntron Co.—"VIBRA-FLOW"

CONVEYORS, SPIRAL

Central Mine Equipment Co.—"CME"
Galis Electric & Machine Co.
Link-Belt Co., Dept. CAMGL-61

CONVEYORS, SPIRAL LOWERING

J. D. Christian Engineers
Holmes Bros., Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.

CONVEYORS, VIBRATING

Ajax Flexible Coupling Co., Inc.—"AJAX LO-VEYOR"
Chain Belt Co.—"CARRIER"
Dravo Corp.
Galis Electric & Machine Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61 "FLEXMOUNT," "COIL-MOUNT," "TORQUEMOUNT"
Simplicity Engineering Co.

COPYING EQUIPMENT

Charles Bruning Co., Inc.

COOLANT SYSTEMS

Trico Fuse Mfg. Co.—"TRICO-MIST"

CORDS, DRILL

Collyer Insulated Wire Co.
Flood City Brass & Electric Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
Western Insulated Wire Co. (neoprene)—"BRONCO 66"

CORDS, PORTABLE, ELECTRIC

Collyer Insulated Wire Co.
Cornish Wire Co., Inc., Div. of General Cable Corp.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.—KAISER MASTER
Okonite Co.
National Electric Div., H. K. Porter Co., Inc.,—"INDE-STRUCTO"
Rome Cable, Div. of Alcoa—"ROME 60," "ROME 50"
Western Insulated Wire Co. (neoprene and rubber)—"BRONCO 66"

COTTER PINS

American Chain Div., American Chain & Cable Co., Inc.

COUNTERSINKING TOOLS, CONVEYOR BELTING

Flexible Steel Lacing Co.—"FLEXCO"

COUPLERS, AUTOMATIC MINE CAR

C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin-Sensenich Corp.
Mayo Tunnel & Mine Equipment
National Castings Co.—"WILLISON," "SHARON 10"
Ohio Brass Co.
Utility Mine Equipment Co.
Rydin Railway Equip. Co.

COUPLERS, MINE-CAR

Utility Mine Equipment Co.

COUPLINGS

Webster Mfg., Inc.

COUPLINGS, AIR-LINE

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories Co.
Lincoln Engrg. Co., div. of McNeil Mach. & Engrg. Co.—"FLEX-O-MATIC"
Marman Div. Aeroquip Corp.—"CONOSEAL"
McDowell Mfg. Co.—"FAST-LINE"
Schroeder Brothers Corp.

COUPLINGS, CHAIN

Acme Chain Corp.
Dodge Mfg. Corp. "TAPER-LOCK"
Link-Belt Co., Dept. CAMGL-61 "RC"

COUPLINGS, CLUTCH

Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-61
Marland One-Way Clutch Co.

COUPLINGS, FIRE HOSE

The Fyr-Fyter Co.
Hewitt-Robins Incorporated

COUPLINGS, FLEXIBLE SHAFT

Ajax Flexible Coupling Co. Inc.
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers

Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER-LOCK," "PARA-FLEX"
Elliott Co.
The Falk Corp.—"STEELFLEX," "AIRFLEX"
Farrel-Birmingham Co., Inc.
Flood City Brass & Electric Co.
Hewitt-Robins Incorporated
Koppers Co., Inc., Metal Products Div.—"FAST'S"
Link-Belt Co., Dept. CAMGL-61 "RC," "GEARED" "MC"
McDowell Mfg. Co.
Morse Chain Co., A Borg-Warner Industry — "MORFLEX" (roller, silent, nylon)
Thomas Flexible Coupling Co.—A Sub. of Koppers Co., Inc. "THOMAS"
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
T. B. Woods Sons Co.—"SURE FLEX"

COUPLINGS, FLUID
Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-61
Twin Disc Clutch Co.

COUPLINGS, FLUID & HYDRAULIC LINES
Aeroquip Corp.—"SELF SEALING"
Blackhawk Industrial Div.
Champ Industries, Inc.
Chiksan Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories Co.
Link-Belt Co., Dept. CAMGL-61
McDowell Mfg. Co.—"FAST-LINE"
The Weatherhead Co.

COUPLINGS, GROOVED-END PIPE
Gustin-Bacon Mfg. Co.—"GRUVAGRIP," "GRUVA-JOINT," "RIGI-GRIP," "ALUMINUM GRUVAGRIP"
Victaulic Co. of America

COUPLINGS, HOSE
Acme Machinery Co.
Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Hunt Valve Co.—"QUICK-AS-WINK"
Hose Accessories
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—"LOKTITE"
Meckum Engineering, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.
United States Rubber Co.—"EVERTITE"
The Weatherhead Co.

COUPLINGS, HYDRAULIC
Link-Belt Co., Dept. CAMGL-61

COUPLINGS, HYDRAULIC-DRIVE
Link-Belt Co., Dept. CAMGL-61

COUPLINGS, MAGNETIC-DRIVE
Eaton Mfg. Co. Dynamatic Div.

COUPLINGS, PLAIN END PIPE
Gustin-Bacon Mfg. Co.—"ROL-AGRIP"
Victaulic Co. of America—"VICTAULIC ROUST-ABOUT," "VICTAULIC PLAINLOCK"

COUPLINGS, RIGID
Browning Mfg. Co..

COUPLINGS, SHAFT
Dodge Mfg. Corp.—"PARAFLUX" "TAPER-LOCK"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

COVERING, FLOOR, STAIR
Minnesota Mining & Mfg. Co. "SAFETY WALK"

CRANES, MOBILE, TRUCK, CRAWLER
American Hoist & Derrick Co.—"AMERICAN"
Austin-Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus-Erie Co.
Dravo Corp.
FWD Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Hyster Co.—"HYSTER KARRY KRANE"
Insley Mfg. Corp.
Koehring Div. of Koehring Co.—"CRUISER-CRANE"
Link-Belt Speeder Corp.—"SEP-HYRCRANES
Marion Power Shovel Co., A Div. of Universal Marion Corp.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Pitman Manufacturing Co.—"PITMAN HYDRA LIFT"
"Quick-Way" Truck Shovel Co.
Ruger Equipment, Inc.—"RUGER"
Schield Bantam Co.—(Truck)
The Thew Shovel Co.—"LORAIN MOTORCRANE"
Unit Crane & Shovel Corp.

CRANES, SHOP & PLANT
American Hoist & Derrick Co.
Austin-Western Construction Equipment Div. Baldwin-Lima-Hamilton Corp.
Columbus McKinnon Corp., Mining Equipment Div.
Harnischfeger Corp.
Manning Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. —"SHAW BOX," "LOAD LIFTER"
Morse Bros. Machinery Co.
Robbins & Myers, Inc.—"R & M"
Shepard Niles Crane & Hoist Corp.

CRAWLER PADS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Caterpillar Tractor Co.
Kensington Steel, Div. of Poor & Co.

CREOSOTE OIL
Republic Creosoting Co., Div. of Reilly Tar & Chemical Corp.

CRIB RELEASE BARS
Mining Progress, Inc.

CROSSING SIGNALS, RAIL HIGHWAY
American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

CRUSHER JAWS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Kensington Steel, Div. of Poor & Co.

CRUSHER REPLACEMENT PARTS
American Manganese Steel Div., American Brake Shoe Co.
American Pulverizer Co.
ESCO Corp.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Holmes Bros., Inc.
Iowa Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pioneer Engineering, Div. of Poor & Co.
Taylor-Wharton Co., Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Williams Patent Crusher & Pulv. Co.

CRUSHERS, HAMMER
American Pulverizer Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.—"BULLDOG"
Holmes Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Sprout, Waldron & Co., Inc.
Sturtevant Mill Co.
Williams Patent Crusher & Pulv. Co.

CRUSHERS, IMPACT
American Pulverizer Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.—"COAL-PACTOR"

CRUSHERS, JAW
American Manganese Steel Div., American Brake Shoe Co.
Denver Equipment Co.—"DENVER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Hammermills, Inc.
Kennedy Van Saun Mfg. & Eng. Corp.
McLanahan Corp.
Mine and Smelter Supply Co. "MASSCO"
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pioneer Engineering Div. of Poor & Co., Inc.
Staub Mfg. Co. Inc.—"KUEKEN"
Traylor Engineering & Mfg., Div. of Fuller Co.

CRUSHERS, LABORATORY
American Pulverizer Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Mine and Smelter Supply Co.—"MASSCO"
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Sturtevant Mill Co.
Williams Patent Crusher & Pulv. Co.
Wise Co., Inc., O. B.

CRUSHERS, RING
American Pulverizer Co.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.—"KNITTEL"
Williams Patent Crusher & Pulv. Co.

CRUSHERS, ROLL
Baldwin-Lima-Hamilton Corp. Construction Equipment Div.—"LIMA AUSTIN WESTERN"
Denver Equipment Co.—"DENVER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Eagle Iron Works
Gruendler Crusher & Pulverizer Co.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc.—"GUNDLACH"
Hammermills, Inc.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Jeffrey Mfg. Co.—"FLEX-TOOTH"
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-61
McLanahan Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pioneer Engineering, Div. of Poor & Co.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Traylor Engineering & Mfg. Div. of Fuller Co.
Webster Mfg. Inc.
Williams Patent Crusher & Pulv. Co.
Wilmot Engineering Co.

CRUSHERS, SAMPLE—See Crushers, Laboratory

CRUSHERS, TWO-STAGE
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc.—"GUNDLACH"
Hammermills, Inc.—"TWIN-DUAL"
Kennedy Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Williams Patent Crusher & Pulv. Co.

CRUSHING PLANTS, PORTABLE STATIONARY
Diamond Iron Works, Div. Goodman Mfg. Co.

CRUSHING & SCREENING PLANTS
Hewitt-Robins Incorporated

CULVERTS, CORRUGATED-METAL
Armco Drainage & Metal Prod., Inc.
Republic Steel—"REPUBLIC"

CUPS, GREASE AND OIL
Link-Belt Co., Dept. CAMGL-61 "HEX-TOP"

CURTAINS, NYLON PLASTIC
Mine Ventilation System, Inc.

CUT-OFF MACHINES, WHEELS, ABRASIVE
Allison-Campbell Div. American Chain & Cable Co., Inc.—"CAMPBELL," "SEVER-ALL," "ALLISON," "CUTAMATIC"

CUT-OUTS, ELECTRICAL
Duquesne Mine Supply Co.
G & W Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.

CUTTER BARS
The Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Frank Prox Company Inc.
Bertrand P. Tracy Co.

CUTTER BARS, REBUILDING
Leman Machine Co.

CUTTER CHAINS
The Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Frank Prox Company, Inc.
Bertrand P. Tracy Co.

CUTTER CHAINS, CONTINUOUS MINER
Cincinnati Mine Machinery Co.—"CINCINNATI"
Frank Prox Company, Inc.

CUTTER LOADERS, DRUM
Herold Mfg. Co.

CUTTERS, BAR, CABLE, CHAIN, ROD, WIRE ROPE, ETC.
Farrell-Cheek Steel Co.
H. K. Porter, Inc.

CUTTING MACHINES
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kersey Mfg. Co., Inc.
Morse Bros. Machinery Co.

CUTTING MACHINES, REBUILT
Leman Machine Co.

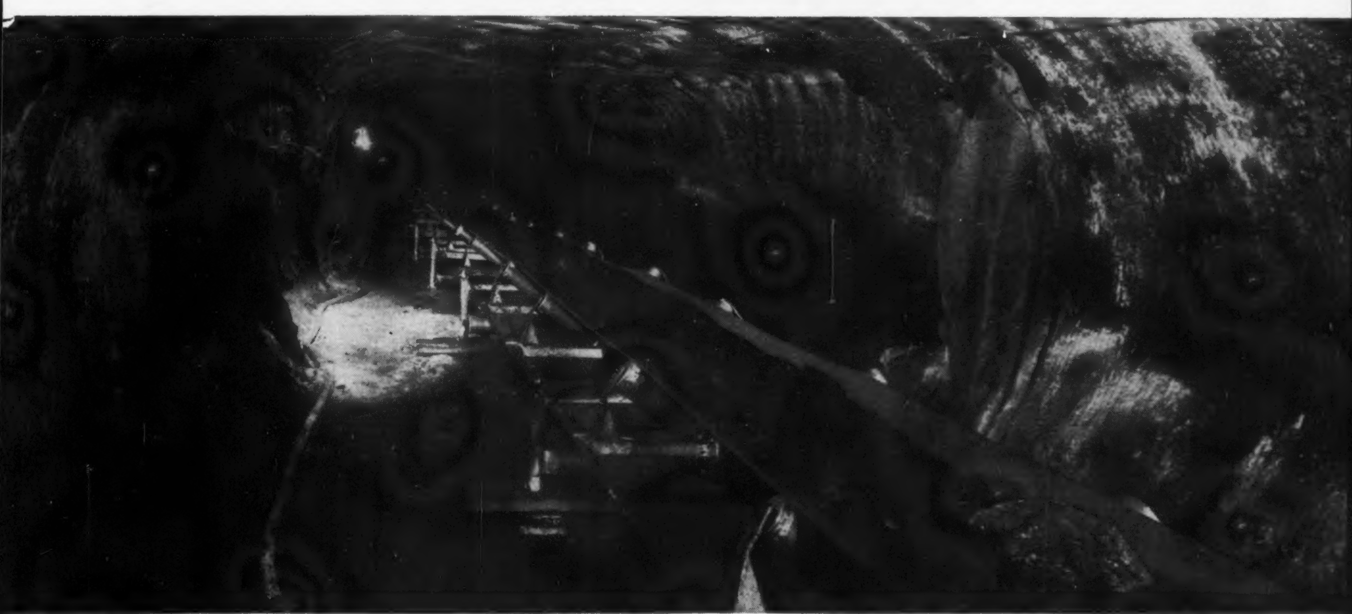
CUTTING MACHINES CONVERTED TRACK TO RUBBER
Lee-Norse Co.
Leman Machine Co.

CUTTING TORCHES—see Welding, Cutting Torches, Outfits

CYCLONES, AIR TREATMENT
Buell Engineering Co., Inc.
Combustion Engineering, Inc., Raymond Div.
The Ducon Co. Inc.—"DUCLONE"
Hardinge Co., Inc.
Roberts & Schaefer Company Division of Thompson-Starrett Company, Inc.
Western Precipitation Div., Joy Mfg. Co.—"MULTICLONE"

CYCLONES, HEAVY-MEDIUM
Buell Engineering Co., Inc.
Heyl & Patterson, Inc.—"H & P"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

CYCLONES, WATER TREATMENT
The Daniels Co.
Denver Equipment Co.



Long-Airdox's development of the "Lo-Rope" principle to perfect modern wire rope side frame design offers many important benefits. Savings in time and labor for installation and maintenance plus greater load-carrying capacity reduce haulage costs to a minimum.

In this design, precision roller bearings are combined with a highly effective labyrinth seal to provide an idler roll that's unequalled in performance. Low idler drag holds pull requirements to a minimum. The floating nylon labyrinth seal offers the advantages of a modern sealed bearing while retaining free-turning and re-greasing ability.

Here are a few more reasons why you can move more coal more profitably with a Long-Airdox "Lo-Rope" belt conveyor.

Reduced labor costs—conveyor stays aligned—platform rocker support stands can't walk out of position.

Increased belt capacity—fixed deep troughing angle (20°, 27°, or 35°) gives greater payload without spillage.

Belt stays centered — design provides automatic self training.

Automatic leveling of belt—made possible by adjustable support stands. Blocking for uneven bottom is eliminated.

Conveyor moves simplified—the "Lo-Rope" has fewer components.

Belting lasts longer—no possible contact with idler or stand connections to wire rope.

For complete information, write the Long-Airdox Company, Division of Marmon-Herrington Company, Inc., Oak Hill, West Virginia.

LONG-AIRDOX

Dorr-Oliver, Incorporated—"DORRCLONE®,"
Galis Electric & Machine Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Kennedy Van Saun Mfg. & Engrg. Corp.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

CYLINDERS, AIR

Hunt Valve Co., Div of IBEC—"HYQUIP"

CYLINDERS, OPERATORS

Ledeen, Inc.

DEMAGNETIZERS

Martindale Electric Co.

DENSITY MEASUREMENT

Automation Products Inc.—"DYNATROL"
Industrial Nucleonics Corp.—"ACCURAY"

DEPRESSANTS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AERO®"

DERAILERS

Gibraltar Equipment & Mfg. Co.—"TIELOCK"
Miners Hardware Supply Co.
The Nolan Co.
Sanford-Day Corp.

DERAILERS, ELECTRIC, AUTOMATIC & REMOTELY CONTROLLED

American Mine Door Co.
Cheatham Elec. Switching Device Co.
General Equipment & Manufacturing Co.

DERRICKS

American Hoist & Derrick Co.
Clyde Iron Works, Inc.

DETECTORS, TRAMP-IRON

Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Industrial Physics & Electronics Co.—"DETRAMP"
Stearns Magnetic Products

DETERGENTS, GERMICIDAL

American Optical Co., Safety Products Div.

DETONATOR BOXES, WOOD

Mine Safety Appliances Co.

DETONATORS, ELECTRIC

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AMERICAN*"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.
Hercules Powder Co.
Olin Mathieson Chemical Corp., Explosives Operations, Energy Div.
National Powder Co.
Trojan Powder Co.

DETONATORS, MILLISECOND-DELAY

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AMERICAN*" "COAL KING"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.
Hercules Powder Co.
Olin Mathieson Chemical Corp., Explosives Operations, Energy Div.—"MINAMAX"
National Powder Co.
Trojan Powder Co.

DETONATORS, SHORT-DELAY

Hercules Powder Co.
Trojan Powder Co.

DETONATORS, STANDARD-DELAY

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AMERICAN*" "COAL KING"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.—"ACUDET"
Hercules Powder Co.
Olin Mathieson Chemical Corp., Explosives Operations, Energy Div.—"VENTLESS"
National Powder Co.
Trojan Powder Co.

DIAMONDS, INDUSTRIAL

Diamond Tool Research Co., Inc.
Hoffman Brothers Drilling Co.
J. K. Smit & Sons
Sprague & Henwood, Inc.

DIAPHRAGMS, PUMPS, VALVES, ETC.

Continental Rubber Works
United States Rubber Co.

DIPPER TEETH, BASES, INSERTS, ETC.

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Steel Foundries—"WEARPACT"
ESCO Corp.—"ESCO"
H & L Tooth Co.
Kensington Steel, Div. of Poor & Co.
Taylor-Wharton Co. Div., Harsco Corp.

DIPPERS, SHOVEL

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
ESCO Corp.—"ESCO"

DISTRIBUTION BOXES, ELECTRICAL, STRIPPING

Atkinson Armature Works
Joy Mfg. Co.
Westinghouse Electric Corp.

DISTRIBUTION BOXES, ELECTRICAL, UNDERGROUND

Albert & J. M. Anderson Mfg. Co.—"POW-R-GARD" "GROUND-GUARD"
Ensign Electric & Mfg. Co.
G & W Electric Specialty Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Ohio Brass Co.
Schroeder Brothers Corp.
Westinghouse Electric Corp.

DISTRIBUTORS, HYDRAULIC COAL FEED—See Feed Distributors, Coal, Revolving

DOCKS, LOADING, UNLOADING

Dravo Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

DOLLIES, PRY

Advance Car Mover Co., Inc.—"BADGER"
Gibralter Equipment & Mfg. Co.

DOORS, FIRE, INDUSTRIAL

Steelcraft Mfg. Co.

DOORS, MINE, MANUAL, AUTOMATIC, AIR POWERED

American Mine Door Co.—"CANTON"

DRAFT GEAR, RUBBER

Enterprise Wheel and Car Corp.
National Castings Co.—"NATIONAL MULTIPAD"

DRAFTING EQUIPMENT, SUPPLIES

Charles Bruning Co., Inc.
Geo-Optic & Paper Corp.
Wild Heerbrugg Instruments, Inc.

DRAGLINES, CRAWLER, RUBBER-TIRED

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div., "LIMA"
Bucyrus-Erie Co.
Gar Wood Industries, Inc.
Harnishfeger Corp.
Insley Mfg. Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Quik-Way Truck Shovel Co.
Schield Bantam Co.
The Thew Shovel Co.
Unit Crane & Shovel Corp.

DRAGLINES, WALKING

Bucyrus-Erie Co.
Marion Power Shovel Co., A Div. of Universal Marion Corp.
Page Engineering Co.

DRILL BOXING

The Leetonia Tool Co.

DRILL CORE BARRELS

Mobile Drilling, Inc.

DRILL EXTRACTORS, MAGNETIC

Dings Magnetic Separator Co.

DRILL JUMBOS

Acme Machinery Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Gibralter Equipment & Mfg. Co.
Ingersoll-Rand Co.—"HYDRA-BOOM"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mayo Tunnel & Mine Equipment
Schroeder Brothers Corp.

DRILL PIPE

Buffalo-Springfield Co., Div. of Koehring Co.
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.
Mobile Drilling, Inc.
National Supply Div., Armco Steel Corp. "SPANGWELD," "DOUBLE SEAL SHRINK THREAD"
National Tube Div. United States Steel Corp.—"USS NATIONAL"

DRILL PRESSES

The Black & Decker Mfg. Co.

DRILL RODS

Mobile Drilling, Inc.

DRILL SHARPENERS

Gardner-Denver Company
Ingersoll-Rand Co.

DRILL STEEL

Acme Machinery Co.
Bethlehem Steel Co.
Brunner & Lay-Eastern, Inc.
Crucible Steel Co. of America—VICTOR®," "CRUCIBLE," "KETOS®," "ALVA EXTRA," "NU-DIE®," "REX®," "SPECIAL," "HALCOMB 218"
Gardner-Denver Company
Gibraltar Equipment & Mfg. Co.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
National Mine Service Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILL STEEL, HOLLOW

Bethlehem Steel Co.
Crucible Steel Co. of America

DRILL THREAD BARS

The Leetonia Tool Co.

DRILL TOOLS, CHURN

Spang & Company

DRILLING RIGS

National Supply Div., Armco Steel Corp.—"NATIONAL"

DRILLS, COAL, HAND-OPERATED

Howells Mining Drill Co.
The Leetonia Tool Co.
Penn Machine Co.
The Salem Tool Co.—"SALEM"

DRILLS, COAL, HAND-HELD, ELECTRIC

Chicago Pneumatic Tool Co.—"WHIPPETT CP"
Ensign Electric & Mfg. Co.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Penn Machine Co.
Schroeder Brothers Corp.

DRILLS, COAL, HAND-HELD HYDRAULIC

Chicago Pneumatic Tool Co.—"CP"
Jeffrey Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Long-Airdox Co. (hand-held)
Penn Machine Co.
Schroeder Brothers Corp.

DRILLS, COAL, UNDERGROUND, MOUNTED SELF-PROPELLED

Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Galis Electric & Machine Co.—"GALIS 400," "GALIS 410," "GALIS 430"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Company—"LEE-NORSE DRILL TRUCK"
Long-Airdox Co.
Penn Machine Co.

DRILLS, COAL, POST-MOUNTED

Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Jeffrey Mfg. Co.
The Leetonia Tool Co.
Morse Bros. Machinery Co.
Penn Machine Co.
The Salem Tool Co.—"SALEM"

DRILLS, COAL RECOVERY—See Augers, coal-recovery

DRILLS, COAL, STRIP-MINE MOUNTED, SELF-PROPELLED

Bucyrus-Erie Co.
Buffalo-Springfield Co., Div. of Koehring Co.—"SPEED STAR," "KEYSTONE FRANKS"
Le Roi Div., Westinghouse Air Brake Co.
Mobile Drilling Co.
Paris Mfg. Co.
The Salem Tool Co.
Winter-Weiss Co.—"PORTA-DRILL"

DRILLS, COMBINATION ROTARY & DOWN THE HOLE

Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"BLASTMASTER" "FP-3 HOLEMASTER"
Long-Airdox Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Schramm, Inc.—"ROTATOOL"

DRILLS, CORE

Acker Drill Co.—"HILLBILLY," "TEREDO," "PACK SACK," "MODELS LD, KR," "PRESIDENTE," "ACKER PACK-SACK (AIR)"
Chicago Pneumatic Tool Co.—"REICHdrill"
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"HOLEMASTER"
Hoffman Brothers Drilling Co.
Holub Industries, Inc.
Joy Mfg. Co.
Mobile Drilling, Inc.
Pennsylvania Drilling Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Sprague & Henwood Inc.
Winter Weiss Co.—"PORTA-DRILL"

DRILLS, MASONRY

Holub Industries, Inc.
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Mobile Drilling, Inc.
Pennsylvania Drilling Co., Masonry Drill Div.

DRILLS, OVERBURDEN, VERTICAL AUGER

Long-Airdox Co.
The Salem Tool Co.—"McCARTHY"—(gasoline, diesel, electric)

DRILLS, PNEUMATIC

Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Davey Compressor Co.—"DAVEY-HOLMAN"
Gardner-Denver Company
Ingersoll-Rand Co.—"VACU-JET," "JACKDRILL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Schramm, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILLS, PROSPECTING

Chicago Pneumatic Tool Co.—"CP" "REICHdrill"
Hossfeld Mfg. Co.—"HOSSFELD DIRECT DRIVE"
Long-Airdox Co.
Mobile Drilling, Inc.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Salem Tool Co.—"McCARTHY" (gasoline, diesel, electric)

DRILLS, ROCK, ELECTRIC

Homelite, a div. of Textron, Inc.—"HOMELITE-(BOSCH)"

DRILLS, ROOF-BOLTING
Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
The Eimco Corp.
J. H. Fletcher & Co.
Galis Electric & Machine Co.—"GALIS 300," "GALIS 320," "GALIS 310"
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILLS, ROOF-BOLTING, ROTARY IMPACTS TOOLS
Impact Rotor Tool, Inc.

DRILLS, ROOF-BOLTING, ROTARY AND PERCUSSION
Galis Electric & Machine Co.

DRILLS, SHOP, ELECTRIC AND AIR
The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.

DRILLS, SHOT
Acker Drill Co. Inc.—"MODEL KR"

DRILLS, SIDEWALL, OVERBURDEN
Chicago Pneumatic Tool Co.—"REICHdrill"
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"HD-1-HOLEMASTER"
Joy Mfg. Co.
Long-Airdox Co.
Mobile Drilling Inc.
Paris Mfg. Co.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
The Salem Tool Co.—"McCARTHY" (gasoline, diesel, electric)

DRILLS, STRIP-COAL, ELECTRIC
Long-Airdox Co.

DRILLS, STRIP-COAL, PNEUMATIC
Chicago Pneumatic Tool Co.—"H-BOOM," "TRACDRIL"
Gardner-Denver Co.
Joy Mfg. Co.—"CHALLENGER"
Long-Airdox Co.
Schramm, Inc.—"PNEUMA-TRACTOR ROTADRILLS, Models P-41 & P-42"; CRAWLER MOUNTED ROTADRILLS, Models C-42 & C-66"
Winter-Weiss Co.—"PORTA-DRILL"

DRILLS, VERTICAL CHURN, OVERBURDEN
Bucyrus-Erie Co.
Buffalo-Springfield Co., Div. of Koehring Co.—"SPEED TAR," "KEYSTONE"

DRILLS, VERTICAL ROTARY, OVERBURDEN
Bucyrus-Erie Co.
Buffalo-Springfield Co., Div. of Koehring Co.—"KEYSTONE-FRANKS"
Chicago Pneumatic Tool Co.—"REICHdrill"
Davey Compressor Co.
Geo. E. Failing Co., Sub. of Westinghouse Air Brake Co.—"HOLEMASTER"
Ingersoll-Rand Co.
Joy Mfg. Co.—"CHAMPION"
Le Roi Div., Westinghouse Air Brake Co.
Long-Airdox Co.
Mobile Drilling Inc.
REICHdrill Div., Chicago Pneumatic Tool Co.—"REICHdrill"
Robbins Machine & Mfg. Co.
The Salem Tool Co.—"McCARTHY"—(gasoline, diesel, electric)
Schramm, Inc.—"ROTADRILL TRUCK MOUNTED, Models T 64 & T 66"; "ROTADRILL CRAWLER MOUNTED, Models C 42 & C 66"
Winter-Weiss Co.—"PORTA-DRILL"

DRILLS, OVERBURDEN, VERTICAL ROTARY, TRUCK-MOUNTED
Le Roi Div., Westinghouse Air Brake Co.

DRILLS, WAGON
Chicago Pneumatic Tool Co.
Long-Airdox Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRIVES, ADJUSTABLE & SELECTIVE SPEED
The Louis Allis Co.—"SELECT-A-SPEDE," "ALLISPEDE"
The American Pulley Co.
J. D. Christian Engineers
Clark Controller Co.
Cleveland Worm & Gear Div., Eaton Mfg. Co.—"VARIATOR" (Mechanical)
Dodge Mfg. Corp.
Eaton Mfg. Co. Dynamatic Div., "AJUSTO-SPEDE," "DYNASPEDE"
Electric Machinery Mfg. Co.—"AMPLI-SPEED"
Electro Dynamic Div. of General Dynamics Corp.
The Falk Corp. (mechanical)
Foote Bros. Gear & Machinery Corp.—"VARI-MOUNT"
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"P.I.V." "R.S.P.I.V."
Manheim Mfg. & Belting Co.—"MVS"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Reeves Pulley Co. Div., The Reliance Electric & Engineering Co.—"VARI-SPEED"
Reliance Electric & Eng. Co.—"RELIANCE V—S"
Sterling Electric Motors, Inc.—A Sub. of Hathaway Instruments, Inc.
U.S. Electrical Motors Inc.—"VARI-DRIVE"
Vickers Incorporated
T. B. Woods Sons Co.
Worthington Corp.

DRIVES, BELT
Dodge Mfg. Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61—Chaintype
Morse Chain Co., A Borg-Warner Industry—"TIMING"

DRIVES, CHAIN
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER-LOCK"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT," "LXS," "RIVETLESS" "RC" "FR," "SILVERBRITE"
Morse Chain Co., A Borg Warner Industry—"HY-VO"
National Supply Div., Armco Steel Corp.—"NATIONAL"
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.

DRIVES, FLANGE-MOUNTED
Dodge Mfg. Corp.
The Falk Corp.
Link-Belt Co., Dept. CAMGL-61

DRIVES, FLUID, HYDRAULIC
AE Industrial Div., Aircraft Armaments, Inc.—"HELE-SHAW"
Dodge Mfg. Corp.—"FLEXI-DYNE"
Link-Belt Co., Dept. CAMGL-61—"ELECTROFLUID"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Twin Disc Clutch Co.
Vickers Incorporated

DRIVES, GEAR, WORM GEAR
The Louis Allis Co.
J. D. Christian Engineers
Cleveland Worm & Gear Div., Eaton Mfg. Co.—"CLEVELAND"
The Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Bros. Gear & Machinery Co.—"GEARMOTOR," "LINE-O-MOTOR," "LINE-O-MOUNT," "SHAFTMOUNT"
Hewitt-Robins Incorporated—"JONES"
Kanawha Mfg. Co.
Link-Belt Co., Dept., CAMGL-61—"LINK-BELT," "PARALLEL," "INLINE HELICAL," "WORM," "UNIVERSAL," "GEARMOTOR," "MOTOGEAR"

The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Pittsburgh Gear Co.
Reliance Elec. & Eng. Co.
U. S. Electrical Motors Inc.—"SYNCRO-GEAR"

DRIVES, SELECTIVE SPEED—See "Drives, adjustable & selective speed"

DRIVES, SHAFT—MOUNTED
Dodge Mfg. Corp.
The Falk Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT"

DRIVES, V-BELT
The American Pulley Co.
J. D. Christian Engineers
Dayton Industrial Products Co.—"DAYTON"
Dodge Mfg. Corp.—"DYNA-V" "TAPER LOCK"
Flood City Brass & Electric Co.
The Gates Rubber Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (W. Va.)
Iowa Mfg. Co.
Kanawha Mfg. Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"POLY-V"
Stephens-Adamson Mfg. Co.
Thermoid Div., H. K. Porter Co., Inc.
Worthington Corp.

DRIVES, VARIABLE SPEED—See "Drives, adjustable & selective speed"

DRIVES, VARIABLE-SPEED EDDY-CURRENT
Dynamatic Div., Eaton Mfg. Co.—"AJUSTO-SPEDE," "DYNASPEDE"
Hewitt-Robins Incorporated
Kanawha Mfg. Co.

DRIVES, VARIABLE-SPEED, HYDRAULIC—See "Drives, fluid, hydraulic"

DRIER—See Dryer

DRYER COLUMNS, CARBIDE-COATED
American Alloy Corp.

DRYER TEMPERATURE & PRESSURE CONTROLS
Hagan Chemicals & Controls, Inc.

DRYERS, CENTRIFUGAL
Bird Machine Co.—"BIRD-HUMBOLDT"
Centrifugal & Mech. Industries, Inc.—"C-M-I"
Hendrick Mfg. Co.
Heyl & Patterson, Inc.—"REINEVELD"
McNally-Pittsburg Mfg. Corp.
WEMCO Div., Western Machinery Co.

DRYERS, CENTRIFUGAL, SOLID-BOWL
Bird Machine Co.—"Bird"

DRYERS, CONTINUOUS ROTARY
Allis-Chalmers Mfg. Co.
Hardinge Co., Inc.
Link-Belt Co., Dept. CAMGL-61—"ROTO-LOUVRE" "FLUID-FLO," "MULTI-LOUVRE"
Standard Steel Corp.

DRYERS, FLUIDIZED BED
Dorr-Oliver Incorporated—"FLUO SOLIDS"
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61—"FLUID-FLO"

DRYERS, THERMAL
Buttner Works, Inc.
J. D. Christian Engineers—"THERM-L-VEYORS"
Combustion Engineering Inc., Raymond Div.—"FLASH"
Nelson L. Davis Co.—"NELDCO"
Denver Equipment Co.—"DENVER"
Dravo Corp.
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Iowa Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"ROTO-LOUVRE," "FLUID-FLO," "MULTI-LOUVRE"
McNally-Pittsburg Mfg. Corp.
Mine and Smelter Supply Co.—"SPINNER," "LOWDEN"

Silver Engineering Works, Inc.—"PARRY TURBULENT ENTRAINMENT"
Western Precipitation Div., Joy Mfg. Co.—"HOLO-FLITE"

DUCKBILL LOADING HEADS
Goodman Mfg. Co.

DUCKBILL LOADING HEADS, REBUILT
Leman Machine Co.

DUCT, AIR
Armco Drainage & Metal Prod., Inc.
Flexaust Co.—"FLEXAUST"
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

DUCT, BUS, ELECTRICAL
I-T-E Circuit Breaker Co.
Johns-Manville—"TRANSITE," "KORDUCT"
National Electric Div., H. K. Porter Co., Inc.
Revere Copper & Brass, Inc.
Westinghouse Electric Corp.

DUMPS, CROSSOVER, KICKBACK
C. S. Card Iron Works
The Nolan Co.

DUMPS, ROTARY, MINE-CAR
C. S. Card Iron Works
Connellsville Corp.
Differential Steel Car Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson - Starrett Company, Inc.

DUST-COLLECTOR TUBES
Bemis Bro. Bag Co.

DUST-COLLECTOR BAGS
Buell Engineering Co., Inc.

DUST COLLECTORS, COAL HANDLING, PREPARATION
American Air Filter Co. Inc.
American-Standard Industrial Div.
Bethlehem Steel Co.
Buell Engineering Co., Inc.
Buttner Works, Inc.
The Ducon Co., Inc.
Joy Mfg. Co.
Kanawha Mfg. Co.
Majac, Inc., Sub. of Blackstone Corp.
McNally-Pittsburg Mfg. Corp.
Pangborn Corp.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Spraying Systems Co.
Western Precipitation Div., Joy Mfg. Co.—"MULTICLONE"
Wheelabrator Corp.—"DUS-TUBE"

DUST COLLECTORS, MINE & DRILL
Acme Machinery Co.
American Air Filter Co. Inc.
Buell Engineering Co., Inc.
The Ducon Co., Inc.
J. H. Fletcher & Co.
Mine Safety Appliances Co.—"DRILDUST BUCKET," "THRU-STEEL"
Schroeder Brothers Corp.

DUST CONDITIONERS, DEDUSTERS
The Johnson-March Co.—"VERTICONE"

DUST CONTROL SYSTEMS
Buell Engineering Co., Inc.
The Johnson-March Corp.—"CHEMJET"

DUST-EXCLUDER BOOTS
United States Rubber Co.—"MULTIFLEX"

DUSTPROOFING EQUIPMENT, LIQUID COMPOUNDS
The Johnson-March Corp.

DUST SAMPLERS
Bausch & Lomb Inc.
Fisher Scientific Co.
Mine Safety Appliances Co.—"MIDGET IMPINGERS"

DUST SEAL CURTAINS

United States Rubber Co.

ELBOWS, RUBBER LINED

Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.—"USCOLITE PLASTIC"

ELECTRICAL CONTACTS

Stackpole Carbon Co.

ELECTRO-MECHANICAL EQUIPMENT

F. R. Hannon & Sons—"HANCO"

ELEVATOR BELTING

American Biltrite Rubber Co. Div. Boston Woven Hose & Rubber Co.—"BOSTON"
B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

ELEVATORS, BELT

Baughman Mfg. Co., Inc.
Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engineering, Inc.
K. Prins & Associates
Republic Rubber Div., Lee Rubber & Tire Co.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
United States Rubber Co.

ELEVATORS, BUCKET

Baldwin-Lima-Hamilton Corp., Construction Equipment Div., —"LIMA AUSTIN-WESTERN"
Baughman Mfg. Co., Inc
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Galis Electic & Machine Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works, Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McLanahan Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Morse Bros. Machinery Co.
Ore Reclamation Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall, Inc.
Universal Road Machinery Co.—"RELIANCE"
Wilmot Engineering Co.

ELEVATORS, MINE-TRANSFER, CAR-LOADING

—See "Conveyors, Elevating"

ENAMELS, MACHINERY

Joseph Dixon Crucible Co.

END BITS

American Steel Foundries—"WEARPACT"

ENGINE FUELS, DIESEL

American Oil Co.

ENGINE-GENERATOR SETS

Allis-Chalmers Mfg. Co.
American Marc, Inc. (2½ to 10 KW)
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Cummins Engine Co., Inc.
GM Diesel, Detroit Diesel Engine Div., General Motors Corp.
Harnischfeger Corp.
Homelite, a div. of Textron, Inc.—"HOMELITE"
The Lincoln Electric Co.—"WELANPOWER"
Morse Bros. Machinery Co.
Murphy Diesel Co.—"MURPHY" dual
Nordberg Mfg. Co.—"POWER CHIEF"
R. H. Sheppard Co., Inc.
Thor Power Tool Co.
Waukesha Motor Co.—"ENGINATORS"
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINE OILS, DIESEL, GASOLINE

The American Oil Co.
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Esso Standard, Div. of Humble Oil and Refining Co.—"ESSO LUBE HDX," "ESTOR HD," "ESSOFLEET H," "DIOL RD," "ESTOR D-3"
Gulf Oil Corp.
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sun Oil Co.—"DYNAVIS," "SOLNUS," "SUNVIS"

ENGINEERS

McDowell Co. Inc.
The Stearns-Roger Mfg. Co.

ENGINEERS, BLASTING VIBRATION

Vibration Measurement Engineers, Inc.

ENGINEERS, COAL PLANTS & FACILITIES

Link-Belt Co.
Southwestern Engineering Co.
O. W. Walvoord, Inc.

ENGINEERS, CONSULTING

Allentown Pneumatic Gun Co.—Pneumatic Gunning
Hewitt-Robins, Incorporated
Industrial Engineering & Const. Co. Inc.
Link-Belt Co., Dept. CAMGL-61
Paul Weir Co., Inc.

ENGINEERS, CONSULTING, CONSTRUCTION

Allen & Garcia Co.
The Daniels Co.
Nelson L. Davis Co.
Hewitt-Robins, Incorporated
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works, Inc.
K. Prins & Associates
Robinson & Robinson, Inc.
Stephens-Adamson Mfg. Co.
G. C. Thomas Mfg. Co.
O. W. Walvoord, Inc.

ENGINEERS, CONSULTING, DESIGNING

Allen & Garcia Co.
Blaw-Knox Co., Blaw-Knox Equipment Div.
The Daniels Co.
Nelson L. Davis Co.
Hewitt-Robins, Incorporated
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61
Peter F. Loftus Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.
Pierce Management, Inc.
K. Prins & Associates
Read Davis
Robinson & Robinson, Inc.
Stephens-Adamson Mfg. Co.
Templeton-Mathews Corp.
O. W. Walvoord, Inc.
Paul Weir Co., Inc.
WEMCO Div., Western Machinery Co.—"WKE"

ENGINEERS, CONSULTING, ELECTRICAL

Allen & Garcia Co.
Herbert S. Littlewood
Peter F. Loftus Corp.
National Electric Coil, Div. of McGraw-Edison Co.

ENGINEERS, CONSULTING, FLOTATION

Denver Equipment Co.—"DENVER"
Heyl & Patterson, Inc.

ENGINEERS, CONSULTING, GEOLOGY

Pennsylvania Drilling Co.
Pierce Management, Inc.
Robinson & Robinson, Inc.
Paul Weir Co., Inc.
J. W. Woomer & Associates

ENGINEERS, CONSULTING, INDUSTRIAL

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works Inc.
Peter F. Loftus Corp.
Robinson & Robinson, Inc.
Stephens-Adamson Mfg. Co.
O. W. Walvoord, Inc.

ENGINEERS, CONSULTING, MECHANICAL

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

ENGINEERS, CONSULTING, MINING

Allen & Garcia Co.
Baton & Co., Geo. S.
Cowin & Co. Inc.
Eavenson, Auchmuty & Greenwald
Herold Mfg. Co.
Hewitt-Robins Incorporated
Kirk & Cowin, Inc.
Link-Belt Co., Dept. CAMGL-61
Peter F. Loftus Corp.
Pierce Management Inc.
Read Davis
Robinson & Robinson, Inc.
Paul Weir Co., Inc.
J. W. Woomer & Associates

ENGINEERS, CONSULTING, PREPARATION

Allen & Garcia Co.
Baton & Co., Geo. S.
Commercial Testing & Engineering Co.
The Daniels Co.—"DMS"
Nelson L. Davis Co.
Eavenson Auchmuty & Greenwald
Fuel Process Co. (Inc.)
Galis Electric & Machine Co.
Hyel & Patterson, Inc.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Pierce Management Inc.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Robinson & Robinson, Inc.
Templeton-Matthews Corp.
O. W. Walvoord, Inc.
Paul Weir Co., Inc.

ENGINEERS, CONSULTING, STRIPPING

Baton & Co., Geo. S.
Eavenson, Auchmuty & Greenwald
Link-Belt Co., Dept. CAMGL-61
Pierce Management Inc.

ENGINEERS, MINE MANAGEMENT

Pierce Management Inc.

ENGINES, BUTANE

Allis-Chalmers Mfg. Co.
Chicago Pneumatic Tool Co.

ENGINES, DIESEL

Allis-Chalmers Mfg. Co.
American Marc, Inc. (7 to 25 hp)
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Cummins Engine Co., Inc.—"CUMMINS TURBODIESEL"
GM Diesel, Detroit Diesel Engine Div., General Motors Corp.
Harnischfeger Corp.
Hercules Motor Corp.
International Harvester Co.
Joy Mfg. Co.
Lister-Blackstone, Inc.
Murphy Diesel Co.—"MURPHY"
Nordberg Mfg. Co.
Page Engineering Co.
R. H. Sheppard Co., Inc.
Waukesha Motor Co.
White Diesel Engine Div. The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINES, DIESEL, AIR-COOLED

Lister-Blackstone, Inc.

ENGINES, DIESEL, MINE-LOCOMOTIVE

Hercules Motor Corp.

ENGINES, DUAL-FUEL

Allis-Chalmers Mfg. Co.
Chicago Pneumatic Tool Co.
International Harvester Co.
Murphy Diesel Co. "MURPHY"
Nordberg Mfg. Co.—"DUAL-FUEL"
White Diesel Engine Div. The White Motor Co.—"WHITE SUPERIOR"
Wisconsin Motor Corp.—"WISCONSIN" air-cooled
Worthington Corp.

ENGINES, GASOLINE

Allis-Chalmers Mfg. Co.
Cities Service Oil Co.
Ford Div. of Ford Motor Co.
Hercules Motor Corp.
International Harvester Co.
Waukesha Motor Co.
Wisconsin Motor Corp.—"WISCONSIN" air-cooled.

ENGINES, NATURAL GAS

Allis-Chalmers Mfg. Co.
American Marc Inc. (2-cyl, 15-hp)
Caterpiller Tractor Co., Peoria, Ill
Chicago Pneumatic Tool Co.

ENGINES, OIL

Allis-Chalmers Mfg. Co.
Chicago Pneumatic Tool Co.
Cities Service Oil Co.
Hercules Motor Corp.
Waukesha Motor Co.
White Diesel Engine Div. The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ETCHERS, ELECTRIC

Martindale Electric Co.

EXHAUST OR FUME STACKS

The Neff and Fry Co.

EXHAUST GAS CONDITIONERS

National Mine Service Co.

EXHAUSTERS

Buffalo Forge Co.—"BUFFALO"
Kennedy-Van Saun Mfg. & Eng. Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Roots-Connersville Blower Div., Dresser Industries, Inc.

EXPANSION JOINTS, BELLOWS

Tube Turns, Div. of Chemetron Corp.

EXPANSION PLUGS, ROOF-BOLTING

National Mine Service Co.
Ohio Brass Co.

EXPLOSIVES—See also

"Ammonia Nitrate, industrial"; "Coal Breakers"; "Blasting Agents"; "Explosives, Liquid Oxygen Type"

EXPLOSIVES, COAL

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AMERICAN"
Atlas Powder Co.—"COALITE," "GELCOALITE," "KOLMITE"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.—"GELOBEL®," "DUOBEL®," "MONOBEL®," "LUMP COAL®"
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Trojan Powder Co.—"TROCOL"

EXPLOSIVES, LIQUID-OXYGEN TYPE

Airmite-Midwest, Inc.

EXPLOSIVE LOADERS, PNEUMATIC

Atlas Powder Co.—"JETLODER"
Spencer Chemical Co.—"POWDER MONKEY"

EXPLOSIVES LOADING & TAMPING MACHINES, HORIZONTAL

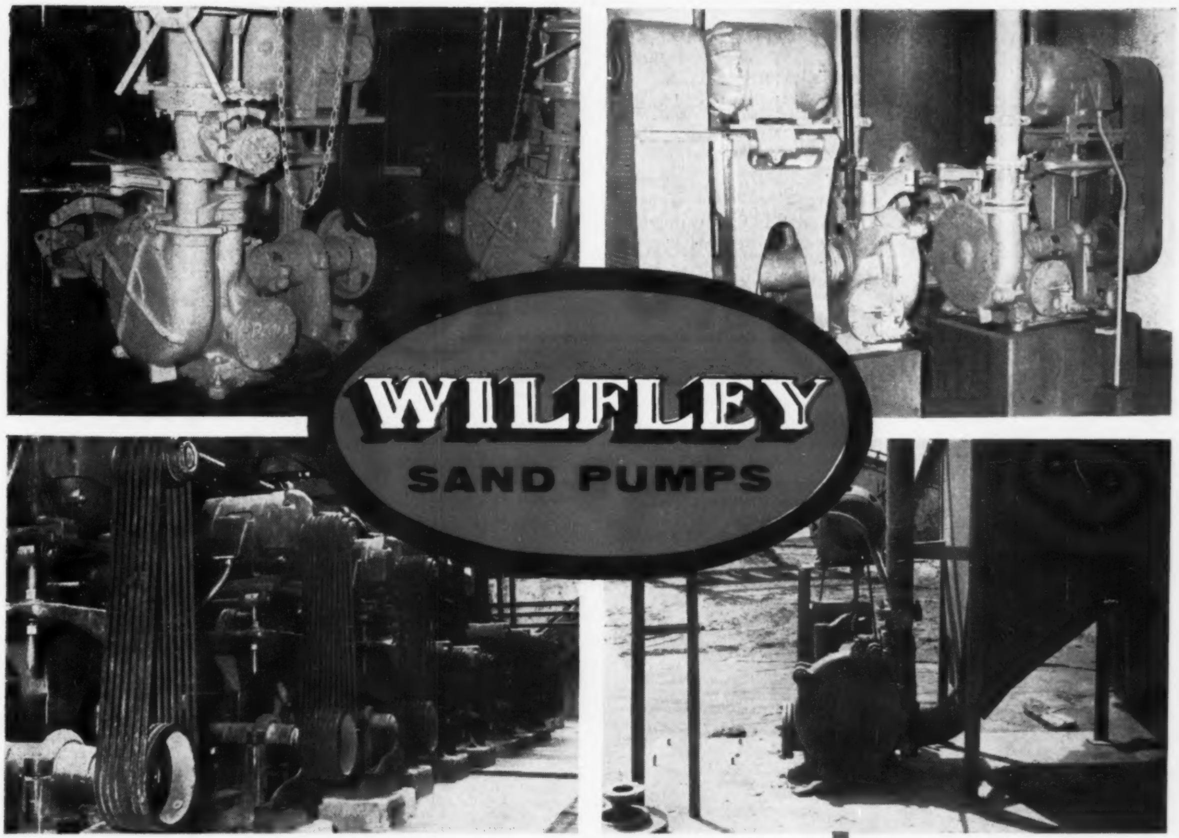
Olin Mathieson Chemical Corp., Explosives Operations, Energy Div.

EXPLOSIVES, PACKAGING, PLASTIC

Visking Co., Plastics Div.—"VIS QUEEN"

EXPLOSIVES, ROCK

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AJAX®," "POWERTOL®," "FREE FLO®," "CYADYN®," "CYATOL®," "CYAGEL 100®,"
Atlas Powder Co.—"APEX," "AMODYN," "GIANT GELATIN," "AMOCORE," "GIANT 75" primer, "RXL 217" primer, "ATLAS-G," non-NG booster
Austin Powder Co.



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National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Trojan Powder Co.

EXTRACTORS, PIPE, SCREW BOLT

The Ridge Tool Co.—"LON GRIP"

EXTRACTORS, RIVET

Crescent Fastener Co.—"CRESCENT"

EYEBOLTS

Bethlehem Steel Co.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY—LAUGHLIN"
Duquesne Mine Supply Co.—"REDIPT"
Republic Steel—"REPUBLIC"

EYE SHIELDS

American Optical Co., Safety Products Div.
Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Martindale Electric Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"SAFI-I-SHIELD," 'SAFI-I-FLEX," "AIR-FLOW," "SAF-I-CHEM"

FABRICATORS, MACHINES, COMPONENTS

Connellsville Corp.
The Daniels Co.
The Falk Corp.
Flood City Brass & Electric Co.
The Galigher Co.
Holmes Bros., Inc.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Leman Machine Co.
Link-Belt Co., Dept. CAMGL-61
Meckum Engineering, Inc.
Ore Reclamation Co.
W. J. Savage Co.
Simplicity Engineering Co.

FABRICATORS, STEEL & STRUCTURES

Bethlehem Steel Co.
Blaw-Knox Co., Blaw-Knox Equipment Div.
Connellsville Corp.
Enterprise Wheel and Car Corp.
Galis Electric & Machine Co.
Holmes Bros., Inc.
Industrial Engineering & Const. Co., Inc.
Irwin-Sensenich Corp.
Kanawha Mfg. Co.
Koven Fabricators, Inc.
Link-Belt Co., Dept. CAMGL-61
Marietta Manufacturing Co.
Meckum Engineering Co.
Ore Reclamation Co.
Phoenix Steel Corp., Structural and Tube Divs.
Roberts & Schaefer Company, Division of Thompson Starrett Company, Inc.
G. C. Thomas Mfg. Co.
Wiley Mfg. Co.

FACE SHIELDS

American Optical Co., Safety Products Div.
E. D. Bullard Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Martindale Electric Co.
Mine Safety Appliances Co.—"FACEGARD," "SUPERGARD," "MINIGARD"
Pulmosan Safety Equipment Co.
United States Safety Service Co.—"HALO"

FAN SIGNALS

Nachod & U. S. Signal Co.

FAN SIGNALS, REMOTE SYSTEMS

Femco, Inc.

FANS, CENTRIFUGAL

American Air Filter Co., Inc.

FANS, EXHAUST, INDUSTRIAL

The Dana Fan & Blower Corp.
Northern Blower Div., Buell Engineering Co., Inc.
Robinson Ventilating Co.

FANS, VENTILATING

Buffalo Forge Co.—"BUFFALO"
E. K. Campbell Co.—"EKCCO"
Clarage Fan Co.
Coppus Engineering Corp.—"VANO," "VENTAIR"
The Dana Fan & Blower Corp.
F. R. Hannon & Sons—"HANCO"
Ilg Electric Ventilating Co.—"ILG"
Jeffrey Mfg. Co.—"AERODYNE"
Joy Mfg. Co.—"AXIVANE"
Robbins & Myers, Inc.—"PROPELLAIR"
Westinghouse Electric Corp.
Westinghouse Electric Corp., Sturtevant Div.
L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co. Inc.—"WING-FOIL"

FASTENERS, PACKAGED

Tool Div., Trans-Atlantic Co.

FASTENERS, QUICK-RELEASE

Elastic Stop Nut Corp. of America—"ESNA ¼-TURN"

FASTENERS, STANDARD & SPECIAL, MINING EQUIPMENT

Bethlehem Steel Co.
Screw and Bolt Corp. of America

FEED DISTRIBUTORS, COAL, REVOLVING

The Deister Concentrator Co., Inc.—"CONCENCO"
Deister Machine Co.
Denver Equipment Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

FEEDER-RETARDERS, MINE CAR

Link-Belt Co., Dept. CAMGL-61
The Nolan Co.

FEEDERS, APRON

Baldwin-Lima-Hamilton Corp. Construction Equipment Div.—"LIMA AUSTIN-WESTERN"
Barber-Greene Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Galis Electric & Machine Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.—"WOBBLER" "PLATE" HYDRA-STROKE"
Helmick Foundry-Machine Co.
Hewit-Robins Incorporated
Holmes Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Eng. Corp.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works
McLanahan Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Smith Engineering Works
Straub Mfg. Co. Inc.
Stephens-Adamson Mfg. Co.
Traylor Engineering & Mfg. Div. of Fuller Co.
Webster Mfg., Inc.
Williams Patent Crusher & Pulv. Co.

FEEDERS, CHAIN

Link-Belt Co., Dept. CAMGL-61
Ross Screen & Feeder Co.—"ROSS," "ROSS" drop-bar

FEEDERS, CHEMICAL, CHLORIDE, LIME, REAGENT, SALT, ETC.

ABCs® Scale Div., McDowell Co., Inc.
B-I-F Industries, Inc.—"HI-WEIGH," "ROTODIP," "ADJUST-O FEEDER," "CHEMO-FEEDER," "PROPORTIONEER"
Denver Equipment Co.—"DENVER"
Galigher Co.—"GEARY"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Manzel Unit of Houdaille Industries, Inc.
Morse Bros. Machinery Co.
W. J. Savage Co.—"SAVAGE-GAUNTT"
Schaffer Poidometer Co.
Syntron Co.

FEEDERS CONTINUOUS-WEIGHING

ABCs® Scale Div., McDowell Co., Inc.
B-I-F Industries, Inc.—"HI-WEIGH," "BELT GALVE-METRIC"
Hardinge Co., Inc.—"CONSTANT WEIGHT"
Industrial Physics & Electronics Co.
Jeffrey Mfg. Co.—"WAYTROL"
Link-Belt Co., Dept. CAMGL-61
Merrick Scale Mfg. Co.—"FEED-OWEIGHT"
Syntron Co.

FEEDERS, ELECTRICAL—See Cable, feeder

FEEDERS, ELECTRICAL—See Cable, feeder

FEEDERS, GRIZZLY

Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61

FEEDERS, MINE-CAR HANDLING

Connellsville Corp.
Galis Electric & Machine Co.
Link-Belt Co. Dept. CAMGL-61
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sanford-Day Corp.
Schroeder Brothers Corp.
Stephens-Adamson Mfg. Co.

FEEDERS, MINE TRANSFER TO BELT OR CAR

Columbus McKinnon Corp., Mining Equipment Div.—"RATIO-FEEDER"
Goodman Mfg. Co.
Hewitt-Robins Incorporated
Irwin-Sensenich Corp.
Jamison Feeder, Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
National Mine Service Co.

FEEDERS, OSCILLATING

Link Belt Co., Dept. CAMGL-61
Webster Mfg. Co.

FEEDERS, PNEUMATIC

Joy Mfg. Co. (low seam)

FEEDERS, RECIPROCATING

American Conveyor Co.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA AUSTIN-WESTERN"
Barber-Greene Co.
Chain Belt Co.—"REX"
Diamond Iron Works, Div. Goodman Mfg. Co.
Galis Electric & Machine Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works
McLanahan Corp.
McNally-Pittsburgh Mfg. Corp.
E. F. Marsh Engrg. Co.—"MARCO' '
Ore Reclamation Co.
Pioneer Engineering Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starret Company, Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Templeton-Matthews Corp.
Transall, Inc.
Universal Road Machinery Co.—"RELIANCE"
Webster Mfg., Inc.
Wilmot Engineering Co.

FEEDERS, SCREW

Link-Belt Co., Dept. CAMGL-61

FEEDERS, VIBRATING

Barber-Greene Co.
Carrier Div. Chain Belt Co.—"CARRIER NATURAL FREQUENCY," "AMPLITROL"
Cleveland Vibrator Co.
Eriez Mfg. Co.
Galis Electric & Machine Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"MC"
National Air Vibrator Co.
Simplicity Engineering Co.—"OS-A-VEYOR"
Stephens-Adamson Mfg. Co.
Syntron Co.—"VIBRA-FLOW"

FENCING, METAL

American Steel & Wire Div., U. S. Steel Corp.—"AMERICAN"
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"REALOCK," "CF&I"
Page Steel & Wire Div., American Chain & Cable Co., Inc.—"CHAINLINK"

FILES, RASPS

Disston Div., H. K. Porter Co., Inc.
Martindale Electric Co.
Snap-on Tools Corp. "SNAP-ON"

FILTER CLOTH, MEDIA

C. R. Daniels Co.
The Eimco Corp.
Filter Fabrics, Inc.
Filtration Engineers Div., American Machine & Metals Inc.
Fisher Scientific Co.
Johns-Manville—"CELITE"
Koppers Co., Inc., Metal Products Div.
Mine Safety Appliances Co.
National Filter Media Corp.
Newark Wire Cloth Co.—"METALLIC"
Peterson Filters & Engineering Co.

FILTER CLOTH, METALLIC

Cleveland Wire Cloth & Mfg. Co.
W. S. Tyler Co.

FILTER MEDIA, AIR

Filter Fabircs, Inc.

FILTERS, AIR

American Air Filter Co., Inc.
A. W. Cash Valve Mfg. Corp.
Coppus Engineering Corp.
The Ducon Co., Inc.
Filter Fabrics, Inc.
Goodyear Tire & Rubber Co.—"PLIOTRON"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Mine Safety Appliances Co.
Western Precipitation Div., Joy Mfg. Co.—"DUALAIRE," "THERM-O-FLEX"
Wheelabrator Corp.—"ULTRA-FILTRATION"

FILTERS, CENTRIFUGAL

Mine Smelter and Supply Co.

FILTERS, DISC, DRUM, VACUUM

Denver Equipment Co.—"DENVER"
Dorr-Oliver, Incorporated
The Eimco Corp.
Filter Fabrics Inc.
Filtration Engineers Div., American Machine & Metals Inc.
Koppers Co., Inc., Metal Products Div.—"AERO TURN"
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.—vacuum, "CONTCUR DRUM" and "DUAL-GUIDE" disk; drum, TFR DRUM, Peterson C. D. (cloth-discharge)

FILTERS, DRUM, VACUUM

Bird Machine Co.—"BIRD-YOUNG"

FILTERS, ENGINE & COMPRESSOR INTAKE

American Air Filter Co., Inc.

FILTERS, FUEL, HYDRAULIC & LUBE OILS

A. W. Cash Valve Mfg. Corp.
Dorr-Oliver, Incorporated
The Duriron Co., Inc.
Filter Fabrics, Inc.
General Equipment & Manufacturing Co.
Infilco Inc., Gale Separator Div.—"IMPINGO," "S.A.,"
Joy Mfg. Co.
Schroeder Brothers Corp.

WORLD'S LARGEST
COAL LOADER
LIFTS
SEVENTEEN TONS
WITH
MUSCLES OF

YELLOW
STRAND

Truax Traer Coal Company depends on Yellow Strand for extra strength and durability at Burning Star Mine #2

Truax Traer's "Little Dipper" at its DuQuoin, Illinois, mine handles more coal per bucket (14 cubic yards) than any other two-crawler loader .... fills a large Euclid wagon in 4 loads. Takes a lot of rope strength to handle such a load. Takes a lot of rope durability to keep such a loader working, too. No wonder the wire rope choice was Yellow Strand–famous for its ability to cut downtime. Whatever your rope needs, depend on Yellow Strand to hold down costs. Depend on your Yellow Strand distributor for satisfaction.

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WIRE ROPE

BRODERICK & BASCOM ROPE CO.
ST. LOUIS • PEORIA • HOUSTON • SEATTLE

United States Rubber Co.—"A.C. OIL"

FILTERS, HORIZONTAL

Bird Machine Co.—"BIRD-PRAYON"
Dorr-Oliver, Incorporated
The Duriron Co., Inc.
The Eimco Corp.

FILTERS, HYDRAULIC, FLAME-RESISTANT FLUIDS

Schroeder Bros. Corp.

FILTERS, MAGNETIC

Magnetic Engr. & Mfg. Co.

FILTERS, WATER

A. W. Cash Valve Mfg. Corp.
Dorr-Oliver, Incorporated
The Duriron Co., Inc.

FIRE ALARMS

Kidde Ultrasonic & Detection Alarms Div.—"KIDDE ATMO"
The Fyr-Fyter Co.

FIRE BRICK

Johns-Manville—"JM," "SIL-O-CEL"
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp. — "JAY BEE," "RAJAH," "AZTEC," "BIG SAVAGE," "MOREX," "NILES NO 1," "NILES H&B," "ALUMEX 50, 60, 70 & 80," "M-20, M-23, M-26, M-28," "BIG 4," "THOR," "VIKING," "DINAS," "VAN DYKE," "BASIC BRICK," "PERICLASE"
H. K. Porter Co., Refractories Dept.

FIRE CARS, TRUCKS, UNDERGROUND

Irwin-Sensenich Corp.
Mine Safety & Appliances Co.
Watt Car & Wheel Co.

FIRE CONTROL, DRY CHEMICAL

Mine Safety Appliances Co.

FIRE DETECTORS

Walter Kidde & Co., Inc.—"KIDDE"

FIRE-EXTINGUISHER FLUIDS

American Minechem Co.
The Fyr-Fyter Co.
United States Rubber Co.

FIRE EXTINGUISHER RECHARGES

American LaFrance Div. of Sterling Precision Corp.—"AMERICAN LA FRANCE"
The Fyr-Fyter Co.

FIRE EXTINGUISHERS

American LaFrance Div. of Sterling Precision Corp.—"AMERICAN LA FRANCE"
Ansul Chemical Co.—"ANSUL"
Cable Vulcanizing Shop, Inc.
Fadlevich Cable Vulcanizing Shop Inc.
The Fyr-Fyter Co.
Walter Kidde & Co., Inc.—"FYRE-FREEZ," "KIDDE"
National Mine Service Co.
Pulmosan Safety Equip. Co.
United States Rubber Co.

FIRE-FIGHTING EQUIPMENT

Cable Vulcanizing Shop, Inc.
Fadlevich Cable Vulcanizing Shop Inc.
J. H. Fletcher & Co.

FIRE FIGHTING EQUIPMENT HIGH PRESSURE FOG

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

FIRE NOZZLES

Bete Fog Nozzle, Inc.

FIREPROOFING MATERIALS

Keasbey & Mattison Co.—"SPRAYED LIMPET ASBESTOS," "KAMKLAD ALUMINIZED ASBESTOS CLOTH®"

FIRE-PROTECTION SYSTEMS

American LaFrance Div. of Sterling Precision Corp.—"AL FITE CO," "FOAMITE AIR-FOAM"
Ansul Chemical Co.—"ANSUL"
The Fyr-Fyter Co.
Grinnell Co.
Walter Kidde & Co., Inc.—"KIDDE CARBON DIOXIDE"

FIRE TRUCKS, APPARATUS

American LaFrance, Div. of Sterling Precision Corp.—"AMERICAN LA FRANCE"
Ansul Chemical Co.—"ANSUL"
FWD Corp.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Mine Safety Appliances Co.

FIRST-AID EQUIPMENT

American Optical Co., Safety Products Div.
Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.—"ALL-WEATHER"
National Mine Service Co.
Pulmosan Safety Equip. Co.

FITTINGS, ALUMINUM CABLE FEEDER

The Elreco Corp.

FITTINGS, CHAIN

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
Farrell-Cheek Steel Co.

FITTINGS, GREASE

Aro Equipment Corp.
Keystone Lubricating Co.
Stewart-Warner Corp., Alemite Div.

FITTINGS, TUBE

Parker Fittings & Hose Div. Parker-Hannifin Corp.—"FERULOK," "TRIPLE-LOK"
The Weatherhead Co.

FITTINGS, WIRE ROPE

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
Farrell-Cheek Steel Co.

FLAME CUTTING MACHINES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.—"LINAGRAPH," "OXYGRAPH," "TRAVOGRAPH," "DUOGRAPH," "RADIAGAPH," "CAMOGRAPH" "MONOGRAPH"

FLAME SAFETY LAMPS

Mine Safety Appliances Co.—"WOLF"
National Mine Service Co.—"KOEHLER"

FLANGE BLOCKS

Browning Mfg. Co.
Link-Belt Co., Dept. CAMGL-61

FLANGED MOUNTINGS ANTI-FRICTION BEARING

Link-Belt Co., Dept. CAMGL-61
SKF Industries, Inc.

FLASHLIGHTS, SAFETY & INDUSTRIAL

General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.

FLIGHTS, CONVEYOR LINE

Link-Belt Co., Dept. CAMGL-61
Remlay Mfg. Co., Inc.

FLOAT & SINK TEST SOLUTIONS

American Minechem Co.—"CERTIGRAV"

FLOAT & SINK TESTERS

Commercial Testing & Engineering Co.
The Daniels Co.
Holmes Bros., Inc.

FLOCCULATING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals—Dept. — "AEROFLOC®" "SUPERLOCK 16®"
American Minechem Co.—"Minefloc"
Denver Equipment Co.
The Dow Chemical Co.—"SEPARAN"
B. F. Goodrich Chemical Co.—"GOOD-RITE K-720"
Hercules Powder Co.
Hodag Chemical Corp.

FLOODLIGHTS

Crouse-Hinds Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Homelite, a div. of Textron, Inc.—"HOMELITE"
National Mine Service Co.
Phoenix Products Co., Inc.—"STURDILITE"
Westinghouse Electric Corp.

FLOODLIGHTS, PORTABLE

Mine Safety Appliances Co.

FLOOR PLATE

United States Steel Corp.—"USS MULTIGRIP"

FLOOR RESURFACERS

Stonhard Co. Inc.—"STONPACH," "STONCAP," "STONHARD RESURFACER," "STONCLAD"

FLOORING, OPEN STEEL

Blaw-Knox Co., Blaw-Knox Equipment Div.

FLOORING, WOOD BLOCK

Republic Creosoting Co., Div. of Reilly Tar & Chemical Corp.

FLOTATION CONDITIONERS

American Minechem Co.
The Daniels Co.
Denver Equipment Co.—"DENVER"
Heyl & Patterson, Inc.
Morse Bros. Machinery Co.
WEMCO Div., Western Machinery Co.—"WEMCO FAGERGREN"

FLOTATION FROTHERS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROFROTH®"
Denver Equipment Co.—"DENVER SUB-A"
Galigher Co.—"AGITAIR"

FLOTATION MACHINES, PLANTS

The Daniels Co.
Denver Equipment Co.—"DENVER SUB-A"
The Galigher Co.—"AGITAIR"
Heyl & Patterson Inc.—"H&P CYCLO-CELL"
Morse Bros. Machinery Co.—"JETAIR"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
The Stearns-Roger Mfg. Co.
WEMCO Div., Western Machinery Co.—"WEMCO FAGERGREN"
Wilmot Engineering Co.

FLOTATION REAGENTS

American Cyanamid Co. Explosives and Mining Chemicals Dept.—"AEROFROTH®"
American Minechem Co.—"MINEFROTH"
Denver Equipment Co.
The Dow Chemical Co.—"DOWFROTH 250"
Hercules Powder Co.
Hodag Chemical Corp.

FLOTATION TESTING LABORATORIES

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
The Galigher Co.

FLOW METERS

B-I-F Industries, Inc.—Dall Flow, Venturi Tubes, Propeloflo

FLUID POWER COMPONENTS

Commercial Shearing & Stamping Co. (pump generators, valve controls, motor drives, cylinder converters)

FLUIDS, HYDRAULIC—
See Hydraulic Fluids

FLUX, WELDING, SALVAGE EQUIPMENT

Holmes Bros., Inc.

FOOTSPRAYERS, MATS

Onox, Inc.—"ONOX"

FORGINGS

American Chain Div., American Chain & Cable Co., Inc.
Bethlehem Steel Co.
Ladish Co.

FREEZEPROOFING CHEMICALS

American Minechem Co.
Fuel Process Co. (Inc.)—"FU PRO CO"
Morton Salt Co.—"FORMULA 5"
Wyandotte Chemicals Corp., Michigan Alkali Div.

FREEZEPROOFING OILS

American Oil Co.

FROTHERS—
see "Flotation Frothers"

FURNACE ENCLOSURES

Bigelow-Liptak Corp.

FURNACE WALLS AND ARCHES

Geo. P. Reintjes Co.

FURNACES, AIR-HEATING

Geo. P. Reintjes Co.

FURNACES, ARCH AND WALL CONSTRUCTION

Bigelow-Liptak Corp.

FURNACES, COAL DRYING

Bigelow-Liptak Corp.
Holmes Bros., Inc.
Mine Smelter Supply Co.—"SKINNER"
Geo. P. Reintjes Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

FURNACES, HEAT TREATING

Hevi-Duty Electric Co., A Div. of Basic Products Corp.

FURNACES, LABORATORY COMBUSTION

Central Scientific Co.
Fisher Scientific Co.
Hevi-Duty Electric Co., A Div. of Basic Products Corp.

FURNACES, METAL-MELTING

Hevi-Duty Electric Co., A Div. of Basic Products Co.
Kuhlman Electric Co.

FUSE, DETONATING

American Cynamid Co., Explosives & Mining Chemicals Dept. "PRIMACORD"
Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc.
The Ensign-Bickford Co.—"PRIMACORD®"
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Propellex Chemical Div. Chromalloy Corp.—"PROPACORD"
Trojan Powder Co.

FUSE, SAFETY, BLASTING

American Cynamid Co., Explosives & Mining Chemicals Dept.
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc.
The Ensign-Bickford Co.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Trojan Powder Co.

FUSE BOXES, EXPLOSIONPROOF

Albert & J. M. Anderson Mfg. Co.

FUSE HOLDERS, ELECTRICAL

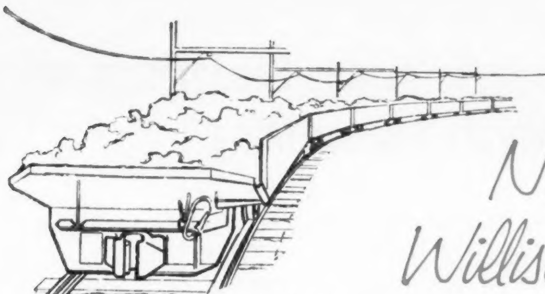
Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Mosebach Electric & Supply Co.

FUSE REDUCERS, ELECTRICAL

Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS"
Holub Industries, Inc.
Trico Fuse Mfg. Co.

FUSES, ELECTRICAL

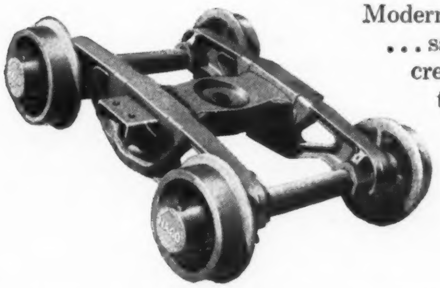
Bussmann Mfg. Div., McGraw-Edison Co.—"BUSS," "FUSETRON"
Economy Fuse Div., Federal Pacific Electric Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.



Get Constant Haulage with*

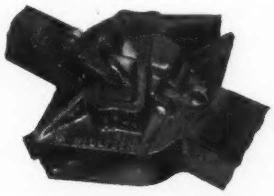
NC-1 Mine Car Trucks
Willison Automatic Couplers
National Rubber Cushioned Devices

*Constant Haulage means volume haulage . . . every minute your mine is operating . . . no costly, undue delays if equipment breaks down.

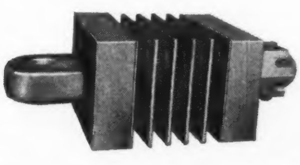


Modern mine cars . . . equipped with National car components . . . save you minutes, hours, pennies, dollars . . . and increase mine production! Check your National representative for details.

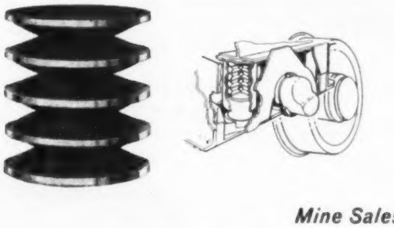
NC-1 Mine Car Trucks. Special load carrying springs with friction snubbing mechanism control vertical and transverse oscillations.



Willison Automatic Couplers. Automatically couple at either end, over wide gathering range, permit higher speeds with greater safety.



Rubber Cushioned Device (Longitudinal). Unit shown absorbs end-to-end impacts, gives soft cushioning action that stretches equipment life.



Rubber Cushioned Device (Vertical). Greater load carrying capacity while minimizing vertical oscillation of cars through high absorption characteristics.

Mine Sales • Transportation Products Division

A-4198AB

Steel Castings Centennial 1861-1961 — Design with Strength in Shape

International Division
Cleveland 6, Ohio

National Castings Company of Canada, Ltd.
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NATIONAL CASTINGS COMPANY

Cleveland 6, Ohio

"JFI Positive Performance Feeder cuts costs six ways at Wyatt-Seanor Mine."

Says John Harvey, Superintendent, Wyatt-Seanor Mine, Simpson Coal and Chemical Corporation.

Simpson Coal and Chemical increased production *and cut costs* when they installed a JFI *positive performance* Feeder in their Wyatt-Seanor Mine in Western Pennsylvania. John Harvey, Wyatt-Seanor Superintendent, reports: "The JFI Feeder allowed us to more fully utilize belt capacity by conveying more coal at slower belt speeds—100 f/p/m *less* than before. Belt wear was noticeably reduced.

"We were also able to eliminate mainline belt spillage from the feeder point to the outside of our mine, and now there is no need to attend belt transfer points. Many man hours are being put to use at more productive jobs. Elimination of surges and overload conditions has reduced mechanical maintenance on belt drives and cut horsepower requirements on those drives."

JFI *Positive Performance* allows high shuttle car discharge rate, complete flexibility of reduction ratio, and profitable multiple belt operation. Feeders are available for both coal and ore mining operations.

If you're after increased production at lower cost, check JFI's complete design and advisory service.

Write today for free literature.

JAMISON FEEDER, INC.

HUNKERS, PENNSYLVANIA TELEPHONE: WAlker 5-7200

JFI

Trico Fuse Mfg. Co.—"TRICO"
Westinghouse Electric Corp.

GAGES, LIQUID-LEVEL
Nathan Mfg. Div., Wegner Machinery Corp.—"GLO ROD"

GAGES, PRESSURE, VACUUM, FLOW
The Bristol Co.—"BRISTOLS"
Foxboro Co.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Div.

GAGES, TRACK
The Aldon Co.
Gibraltar Equipment & Mfg. Co.—"GEMCO TRU-BLU"
The Leetonia Tool Co.

GALVANOMETERS, BLASTING
American Cyanamid Co., Explosives and Mining Chemicals Dept.
Hercules Powder Co.
Trojan Powder Co.

GAS DETECTORS, MINE
Mine Safety Appliances Co.—"W-8 METHANE, M-6 METHANE"
National Mine Service Co.

GAS MASKS
E. D. Bullard Co.
The Fyr-Fyter Co
Mine Safety Appliances Co.—"ALL-SERVICE"
Pulmosan Safety Equip. Co.

GASKETS & MATERIALS
Anchor Packing Co.
Garlock Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Johns-Manville—"GOETZE" "SPIROTALLIC," "SERVICE® SHEET"
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"RM"
United States Rubber Co.

GASOLINE HAMMERS
Syntron Co.

GEARMOTORS
Allis-Chalmers Mfg. Co.
The Louis Allis Co.
J. D. Christian Engineers—"RITE-LO-SPEED"
Continental Conveyor & Equipment Co.
Electro Dynamic Div. of General Dynamics Corp.
Elliott Co.
Ensign Electric & Mfg. Co.
The Falk Corp.—"MOTOREDUCERS ALL-MOTOR"
Foote Bros. Gear & Machinery Corp.
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT," "GEARMOTORS," "MOTOGEARS"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Ore Reclamation Co.
Reliance Elec. & Eng. Co.
W. J. Savage Co.
Sterling Electric Motors, Inc., a sub. of Hathaway Instruments, Inc.
Transall, Inc.
Westinghouse Electric Corp.

GEARMOTORS, RIGHT-ANGLE
Cone-Drive Gears Div., Michigan Tool Co.
Link-Belt Co., Dept. CAMGL-61

GEARS
J. D. Christian Engineers
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Farrell-Cheek Steel Co.
Flood City Brass & Electric Co.
Foote Bros. Gear & Machinery Corp.—"DUTI-RATED"
FWD Corp.
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.—"MICRALOY," "BRONZALOY"
Mosebach Electric & Supply Co.
North American Gear Co.—"NAMCO"
Penn Machine Co.
Pittsburgh Gear Co.
W. J. Savage Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall Inc.
West Virginia Armature Co.
Westinghouse Electric Corp.
Wilmot Engineering Co.

GEARS, MINE-LOCOMOTIVE, HEAT-TREATED
Penn Machine Co.
Farrell-Cheek Steel Co.

GEARS, PLASTIC
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
United States Rubber Co.

GEARS, REDUCTION
Link-Belt Co., Dept. CAMGL-61
Mining Progress, Inc.

GEARS, REVERSE & REDUCTION
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61
Twin Disc Clutch Co.

GEARS, SEMI-STEEL
Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-61
McLanahan Corp.

GEARS, WORM
Cone-Drive Gears Div., Michigan Tool Co.
DeLavel-Holroyd, Inc.
Hewitt-Robins Incorporated
Illinois Gear & Macnine Co.
Link-Belt Co., Dept. CAMGL-61

GENERATOR CONTROL
Electric Machinery Mfg. Co.—"AUTO SYNCHRONIZEN"

GENERATORS, AC
Electric Machinery Mfg. Co.—"AMP-PAK"

GENERATORS, AC, DC
American Marc Inc. (½ to 100-kw)
Electric Products Co.
The Louis Allis Co.
Westinghouse Electric Corp.

GEOPHYSICAL SURVEYS, AIRBORNE
Fairchild Aerial Surveys

GLOVES
American Optical Co., Safety Products Div.
General Scientific Equipment—"GS"
Hood Industrial Footwear—neoprene and plastic gloves—"FLEXIPRENE," "FLEXIGLUV," "GRIP-ALL," "KOROSEAL,"—plastic "ARRASKYN"
Johns-Manville—"WEAR-BESTOS"
Mine Safety Appliances Co.—"ALL-PURPOSE"
Pulmosan Safety Equip. Co.
Riegel Textile Corp.—"RIEGEL"

GLOVES, RUBBER
Continental Rubber Works
Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Goodall Rubber Co.
Hood Industrial Footwear—gloves—"GRIP-ALL," "ARRASKYN' '
B. F. Goodrich Industrial Products Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Rubber Co.

GOGGLE-CLEANING STATIONS
American Optical Co., Safety Products Div.
General Scientific Equipment Co.—"GS"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"SAF-I-CUP"

GOGGLES
American Optical Co., Safety Products Div.
Bausch & Lomb Inc.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.—"GS"
Martindale Electric Co.
Mine Safety Appliances Co.—"SOFTSIDES"
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"SAF-I-CUP"

GOVERNORS, COMPRESSED-AIR, UNLOADING
R. Conrader Co., Inc.—"CONRADER"

GRADER BLADES
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Colorado Fuel & Iron Corp.—"CF&I"
ESCO Corp.— "ESCO"
Galion Iron Works & Mfg. Co.
The Frank G. Hough Co.

GRADERS, MOTOR
Allis-Chalmers Mfg. Co.
Austin-Western Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER WARCO"
LeTourneau-Westinghouse Co.

GRAPHITE, LUBRICATING & GREASES
The American Oil Co.
Joseph Dixon Crucible Co.
Esso Standard, Div. of Humble Oil and Refining Co.—"VANCAZAR," "VAN ESTAN," "VAN NAKTA"
Keystone Lubricating Co.

GRATING, FLOOR, STAIR
Blaw-Knox Co., Blaw-Knox Equipment Div.
Dravo Corp.
Hendrick Mfg. Co.

GREASE-LINE EXTENSIONS AND FITTINGS
National Mine Service Co. (Clarkson Div.)—"CLARKS"

GREASES
The American Oil Co.
The Atlantic Refining Co.
Bearings, Inc.
Cities Service Oil Co.
Gulf Oil Co.
Hulburt Oil & Grease Co.—"HULBURT 4AP, 5AP, 6AP, 8AP, No. 3, No. 4"
Lubriplate Div., Fiske Bros. Refining Co.—"LUBRIPLATE"
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Pennsylvania Refining Co.
The Pure Oil Co.—"POCO HT-EP," "POCO GEARSHIELD," "POCO LOADER GREASE"
Shell Oil Co.
Sinclair Refining Co.—"LITHOLINE," "SINCOLUBE,' "No. 217," "PENNANT GREASES"
Sun Oil Co.—"PRESTIGE"
Swan-Finch Petrochemicals
Texaco Inc.—"THERMATEX," "NOVATEX"

GRINDERS, BIT
Fairview Bit Co.—"FAIRVIEW AUTO-MATIC"
Herold Mfg. Co.
Ingersoll-Rand Co.

GRINDERS, PORTABLE
The Black & Decker Mfg. Co.—(Electric)
Chicago Pneumatic Tool Co.—(air, electric)
Ingersoll-Rand Co.
Joseph T. Ryerson & Son, Inc.
Thor Power Tool Co.

GRINDERS, STATIONARY
The Black-Decker Mfg. Co.—(Electric)
Fisher Scientific Co.
Lippmann Engineering Works Inc.
Remington Arms Co., Inc.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.—"SNAPON"

GRINDING WHEELS
Kennametal, Inc., Mining Tool Div.
Minnesota Mining & Mfg. Co.—"PG"
Norton Co.—"ALUMDUM CRYSTOLON"
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"MANHATTAN"
Joseph T. Ryerson & Son, Inc.
Snap-onToolsCorp.—"SNAP-ON"
United States Rubber Co.

GRINDING WHEELS, DIAMOND
Hoffman Brothers Drilling Co.
Norton Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
J. K. Smit & Sons—"SECOMET"

GRIZZLIES
Cleveland Wire Cloth & Mfg. Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Hammermills, Inc.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Kennedy Van Saun Mfg. & Eng. Co.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engineering Works Inc.
McLanahan Corp.
McNally-Pittsburg Mfg. Corp.
Nordberg Mfg. Co.—"SYMONS"
Simplicity Engineering Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"LIVE ROLL"
Travlor Engineering & Mfg. Div. of Fuller Co.
W. S. Tyler Co.—"Ty-ROCK," "TYLER NIAGARA"

GRIZZLIES, VIBRATING
Syntron Co.

GROUND CLAMPS
Albert & J. M. Anderson Mfg. Co.
Duquesne Mine Supply Co.
Erico Products, Inc.—"CADDY"
Mosebach Electric & Supply Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

GROUND DETECTORS
Central Mine Supply Co. Div., Pickard Industries, Inc.—"PROTECTO"
National Mine Service Co.—"GROUND SENTINEL"
Schroeder Brothers Corp.

GROUND RODS
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

GROUSER BARS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Stulz-Sickles Co.—"SSHI-C"

GROUT, CHEMICAL
American Cyanamid Co., Explosives & Mining Chemicals Dept.—"AM*9"

GROUTERS, PNEUMATIC
Mays Tunnel & Mine Equipment

GROUTING
Allentown Pneumatic Gun Co.—Allentown Pneumatic Gun
Hoffman Brothers Drilling Co.
Mott Core Drilling Co.
Pennsylvania Drillig Co.
Sika Chemical Corp.—"INTRAPLAST"

GROUTING EQUIPMENT
Sprague & Henwood
Mays Tunnel & Mine Equipment

HACK-SAW BLADES
Disston Div., H. K. Porter Co. Inc.
Snap-on Tools Corp.—"SNAP-ON"

HAMMERS, AIR
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Mining Progress, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.
Worthington Corp.

HAMMERS, ELECTRIC
The Black & Decker Mfg. Co.
Homelite, a div. of Textron, Inc.—"HOMELITE-(BOSCH)"

HAMMERS, REPLACEABLE SOFT-FACE
Snap-on Tools Corp.—"SNAP-ON"


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HANDLES, TOOL

The Leetonia Tool Co.
Marion Handle Mills, Inc.—"ACE VIRGINIAN," "A GRADE"
The Salem Tool Co.—"BLACK DIAMOND," "PERFECT"

HANDRAIL & FITTINGS, ALUMINUM

Aluminum Co. of America
Reynolds Metals Co.

HANGERS, SHAFT—See Shaft Hangers

HARDFACING FLUXES

The Lincoln Electric Co.—"LINCOLN WELD H535, H545, H550, H560, M-210"

HARDFACING SERVICE

Americal Alloy Corp.

HARD SURFACING MATERIALS

Air Reduction Sales Co., A Div. Air Reduction Co., Inc.—"AIRCOLOY," "AIRCOLITE," "R-MANG," "AIR-MANG," "TIMANG," "TUNGTUBE," "AIROD," "TEMPALLOY"
Alloy Rods Co.—"WEAR-ARC," "WEAR-FLAME," "WEAR-O-MATIC WIRE"
American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
Ampco Metal, Inc.—"AMPCO TRODE"
Coast Metals, Inc.
Crucible Steel Co. of America—"REXWELD®"
Eutectic Welding Alloys Corp.
Huntington Alloy Products Div., International Nickel Co., Inc.
The Lincoln Electric Co.—"ABRASOWELD," "MANGANWELD," "JET-HARD "BU 90," "FACEWELD," "SURFACEWELD," "STAINWELD," "TOOLWELD," "WEARWELD," "MANGJET"
Metal & Thermit Corp.—"HARDEX"
Rexarc, Inc.—"REXARC"
Stoody Co.—"STOODY"
Stulz-Sickles Co.—"SEACO," "STULZ UNIVERSAL HARDFACE," "STULZ SPRAY-ROD"
Taylor-Wharton Co. Div. Harsco Co.—"TIMANG"
Wall Colmonoy Corp.—"COLMONOY"

HARDWARE—BUILDERS AND CONTRACT

Tool Div., Trans-Atlantic Co.

HAULAGES, R. R. CAR, BOAT

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61

HAULERS—See "Trucks, automotive," "Trucks, off-highway"

HEADLIGHTS

Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Guyan Machy. Co.—"GUYAN"
Imperial-Cantrell Mfg. Co.—"I. C."
Jeffrey Mfg. Co.

HEADLIGHTS, MINE LOCOMOTIVE

Schroeder Brothers Corp.

HEATERS, OIL

Dravo Corp. (gas)
Hauck Mfg. Co.

HEATERS, PANEL & UNIT

United States Rubber Co.—"USKON"

HEATERS, UNIT

American Air Filter Co., Inc.
American-Standard Industrial Div.—"VENTURAFIN"
Buffalo Forge Co.—"BUFFALO"
E. K. Campbell Co.—"THERMIDAIRE"
Clarage Fan Co.
Crane Co.
Dravo Corp.
Grinnell Co.
Ilg Electric Ventilating Co.—"ILG"
Westinghouse Electric Corp., Sturtevant Div.
L. J. Wing Co. Div. of Aero Supply Mfg. Co. Inc.—"WING REVOLVING"

HEATING PLANTS

Axeman-Anderson Co.
E. K. Campbell Co.—"THERMIDAIRE"
Dallas Engineers Inc., Coal-O-Matic Div.—"ANTHRAFLOW," "COAL-O-MATIC"
Dravo Corp.

HEAVY-MEDIA RECLAMATION SYSTEMS

The Daniels Co.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Denver Equipment Co.—"DECO"
Heyl & Patterson, Inc.—"H & P"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Mine and Smelter Supply Co.—"AKINS"
Norton-Tividale, Ltd.
WEMCO Div., Western Machinery Co.—"WEMCO"

HEAVY-MEDIA SEPARATORS

The Daniels Co.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Dravo Corp.
Fuel Process Co. (Inc.)
Gales Electric & Machine Co.
Hardinge Co., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Mine and Smelter Supply Co.—"AKINS"
Norton-Tividale, Ltd.
K. Prins & Associates
Robert & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sterns Magnetic Products
WEMCO Div., Western Machinery Co.—"WEMCO MOBIL-MILL"

HEEL BLOCKS, SWITCH

Bethlehem Steel Co.

HIGH-VOLTAGE TESTING EQUIPMENT

F. R. Hannon & Sons—"HANCO"

HINGES, MINE-DOOR

National Mine Service Co. (Clarkson Div.)—"CLARKSON"

HITCHINGS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Duquesne Mine Supply Co.
Enterprise Wheel and Car Corp.
Irwin-Sensenich Corp.
National Castings Co.
Sanford-Day Corp.

HOIST CONTROLLERS

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Flood-City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Morse Bros. Machinery Co.

HOIST HOOKS

Bethlehem Steel Co.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
Duquesne Mine Supply Co.
The Upson-Walton Co.

HOIST SIGNALLING COMMUNICATION

Femco, Inc.—"CAGE-PHONE"
Industrial Physics & Electronics Co.
Mine Safety Appliances Co. — "HOISTPHONE"

HOISTS, AIR, PORTABLE

Aro Equipment Corp.
Chicago Pneumatic Tool Co.
Coffing Hoist Div., Duff-Norton Co.—"QUICK-LIFT"
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "LOAD LIFTER" "TUG-IT," "SHAW BOX"
Ruger Equipment Inc.
Schroeder Brothers Corp.
Shepard Niles Crane & Hoist Corp.
Thor Power Tool Co.
Yale & Towne Mfg. Co.—"LOAD KING"

HOISTS, ELECTRIC, PORTABLE

AE Industrial Div., Aircraft Armaments, Inc.—"LO-HED"
American Hoist & Derrick Co.
Aro Equipment Corp.
Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"QUICK-LIFT"
Columbus McKinnon Corp., Mining Equipment Div.—"LODESTAR"
Denver Equipment Co.—"DENVER"
Harnischfeger Corp.
Holmes Bros., Inc.
Hewitt-Robins Incorporated
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "LOAD LIFTER "TUG-IT," "SHAW BOX"
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Robbins & Myers, Inc.—"R & M"
Ruger Equipment, Inc.
Sanford-Day Corp.
Schroeder Brothers Corp.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"
Yale & Towne Mfg. Co.—"MIDGET KING," "CABLE KING," "LOAD KING"

HOISTS, HAND-POWERED

J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"SAFETY PULL," "SUPER POWER"
Columbus McKinnon Corp., Mining Equipment Div.
Denver Equipment Co.—"DENVER"
Harnischfeger Corp.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUGIT," "SHAW BOX"
Morse Bros. Machinery Co.
Ore Reclamation Co.
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Stephens-Adamson Mfg. Co.
Yale & Towne Mfg. Co.—"PUL-LIFT," "LOAD KING"

HOISTS, LAYER-LOADING

Holmes Bros., Inc.
Sanford-Day Corp.

HOISTS, LOADING-BOOM

Morse Bros. Machinery Co.
Robert & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sanford-Day Corp.
Shepard Niles Crane & Hoist Corp.

HOISTS, MONORAIL

AE Industrial Div., Aircraft Armaments, Inc. "LO-HED"
Coffing Hoist Div., Duff-Norton Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUGIT," "SHAW BOX," "LOAD LIFTER"
Robbins & Myers, Inc.—"R & M"
Joseph T. Ryerson & Son Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, SCRAPER

American Hoist & Derrick Co.—"AMERICAN"
Ingersoll-Rand Co.
Joy Mfg. Co.
Sauerman Bros., Inc.

HOISTS, MINE-SHAFT

Connellsville Corp. (including friction-type)
Holmes Bros., Inc.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"SHAW-BOX"
Mayo Tunnel & Mine Equipment—"KOEPE"
Morse Bros. Machinery Co.
Nordberg Mfg. Co. (including friction-type)
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

HOISTS, MINE-SLOPE

Holmes Bros., Inc.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

HOISTS, TRUCK-BODY

Galion Allsteel Body Co.
Gar Wood Industries, Inc.
The Heil Co., TEC Div.—"HEIL"
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marion Metal Products Co.
Perfection Steel Body Co.
Tulsa Products Div. Vickers, Inc.

HOLDBACKS, CONVEYOR

Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61
Stephens-Adamson Mfg. Co.

HOPPERS—See Bins & Hoppers, Coal, Storage & Blending

HOPPER LOADERS, UNDERGROUND

The Eimco Corp.

HOPPER OUTLETS, NONPLUGGING

The Bin-Dicator Co.—"BIN-DICATOR HYPERBOLIC"

HOPPERS, WEIGH

Industrial Physics & Electronics Co.
The Nolan Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.

HOSE, AIR

Acme-Hamilton Mfg. Corp.
Acme Machinery Co.
Aeroquip Corp.
Anchor Equipment Corp.
Aro Equipment Corp.
American Biltrite Rubber Co., Boston Woven Hose & Rubber Co., Div.—"BOSTON"
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Continental Rubber Works—"VITAULIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Eimco Corp.
The Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"COMMANDER," "TYPE 88," "TYPE 50," "MAXEGON ALL PURPOSE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"MONARCH," "AJAX," "HEWITT," "MALTESE CROSS"
Joy Mfg. Co.
Lincoln Engrg. Co. Div. of McNeil Mach. & Engrg. Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TOWER"
Schroeder Brothers Corp.
Thermoid Div., H. K. Porter Co., Inc.
Thor Power Tool Co.
United States Rubber Co.
The Weatherhead Co.

HOSE, AIR-SHOOTING

Aeroquip Corp.
Central Mine Supply Div., Pickard Industries, Inc.—"SEAL-TITE"
Long-Airdox Co.

HOSE, COAL WASHING

B. F. Goodrich Industrial Products Co.—"CONVERTAPIPE"

HOSE, FIRE

Acme-Hamilton Mfg. Corp.
American LaFrance, Div. of Sterling Precision Corp.—"AMERICAN LA FRANCE," "GOODYEAR"
American Biltrite Rubber Co. Boston Woven Hose & Rubber Co., Div.—"BOSTON"
Carlyle Rubber Co., Inc.
The Fyr-Fyter Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"PINNACLE," "COMMANDER," "SOLAR," "MAINSTAY," "CASCADE," "B.F.G. SIGNAL"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"AJAX," "MONARCH," "MALTESE CROSS"
Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC 600"
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE, FLEXIBLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
American Biltrite Rubber Co. Boston Woven Hose & Rubber Co., Div.—"BOSTON"
Carlyle Rubber Co., Inc.
The Eimco Corp.
Farris Flexible Valve Corp.—"FLEX VALVE," "SUPER SEAL"
Flexaust Co.—"FLEXAUST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CONVERTA-PIPE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Joy Mfg. Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.
The Weatherhead Co.

HOSE, FLEXIBLE METAL

Cobra Metal Hose, Div. DK Mfg. Co.

HOSE, GREASE & OIL

Aeroquip Corp.
Aro Equipment Corp.
American Biltrite Rubber Co. Boston Woven Hose & Rubber Co., Div.—"BOSTON"
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Lincoln Engrg. Co. Div. of McNeil Mach. & Engrg. Co.
Raybestos Manhattan Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Stewart-Warner Corp., Alemite Div.
Weatherhead Co., Fort Wayne Div.

HOSE, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Blackhawk Industrial Div.
Carlyle Rubber Co., Inc.
Central Mine Supply Co., Div., Pickard Industries, Inc. —"SEALTITE"
Champ Industries, Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Mining Machine Parts, Inc.
National Mine Service Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"WIRETEX"
Schroeder Brothers Corp.
Stewart Warner Corp., Alemite Div.—"SURGEPRUF"
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, LINED

Linatex Corp. of America—"LINATEX"

HOSE, ROCK-DUST

American Mine Door Co.
B. F. Goodrich Industrial Products Co.—"DUSTEX"
Hewitt-Robins Incorporated
Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

HOSE, STEAM

Acme-Hamilton Mfg. Corp.
Aeroquip Corp.
American Biltrite Rubber Co., Div. Boston Woven Hose & Rubber Co.—"BOSTON"
B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated

Raybestos Manhattan Inc., Manhattan Rubber Div.
United States Rubber Co.

HOSE, SUCTION, DISCHARGE

Acme-Hamilton Mfg. Corp.
American Biltrite Rubber Co., Div. Boston Woven Hose & Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CASCADE," "MAXECON," "MORECON," "SPIROLOCK," "TYPE 81 FOR WATER," "TYPES 400, 200, 150, 100, FOR OIL," "TYPE 82-A FOR GASOLINE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE, WATER

Acme-Hamilton Mfg. Corp.
American Biltrite Rubber Co., Div. Boston Woven Hose & Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
The Gates Rubber Co.
Gering Plastics, div. of Studebaker Packard Corp. —"GERING (T-M)"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"JUPITER DELUGE ALARM"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated —"MONARCH," "AJAX," "HEWITT"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Ore Reclamation Co.
Plymouth Rubber Co .Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TONKA"
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

HOSE ASSEMBLIES, SPLIT FLANGE

Anchor Coupling Co. Inc.

HOSE CLAMPS

Chicago Pneumatic Tool Co.
Hose Accessories Co.
Marman Div., Aeroquip Corp.

HOSE FITTINGS

Aeroquip Corp.—"SOCKET-LESS," "LITTLE GEM," "SUPER GEM"
Anchor Coupling Co., Inc.
American Biltrite Rubber Co., Div. Boston Woven Hose & Rubber Co.—"BOSTON"
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Hose Accessories Co.
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.
Long-Airdox Co.
Mining Machine Parts, Inc.
Parker Fittings & Hose Div., Parker Hannifin Corp. —"HOZE-LOK"
Schroeder Brothers Corp.
The Weatherhead Co.

HOSE FITTINGS, DETACHABLE & REUSABLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Continental Rubber Works
Goodall Rubber Co.
Hewitt-Robins Incorporated
Hose Accessories Co.
Hunt Valve Co.—"QUIK-AS-WINK"
Lincoln Engrg. Co., Div. of Mc-

Nekl Mach. & Engrg. Co.—"LOKTITE"
Mining Machine Parts, Inc.
Parker Fittings & Hose Div., Parker Hannifin Corp.—"HOSE-LOK," "PUSH-LOK"
Schroeder Brothers Corp.
Thermoid Div. of H. K. Porter Co. Inc.
The Weatherhead Co.

HOSE FITTINGS, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Champ Industries, Inc.
Continental Rubber Works
Goodall Rubber Co.
Hose Accessories Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Joy Mfg. Co.
Schroeder Brothers Corp.
Stewart-Warner Corp., Alemite Div.—"SURGEPRUF"
Thermoid Div. of H. K. Porter Co., Inc.
United States Rubber Co.
The Weatherhead Co.

HOSE FITTINGS, SWAGED

The Weatherhead Co.

HOSE & TUBE COMBINATIONS

Anchor Coupling Co., Inc.

HYDRAULIC ACCUMULATORS

Parker Hydraulics Div., Parker-Hannifin Corp.—"PARKER"
Schroeder Brothers Corp.
Megator Corp.—"MEGATOR-CONFLOW"

HYDRAULIC CIRCUIT TESTING EQUIPMENT

Megator Corp.—"MEGATOR," "CONFLOW"
Schroeder Brothers Corp.

HYDRAULIC CONTROL UNITS

Caterpillar Tractor Co.
Megator Corp.—"MEGATOR" CONFLOW"

HYDRAULIC CYLINDERS

Bethlehem Steel Co.
Blackhawk Industrial Div.
Hunt Valve Co., Div of IBEC—"HYQUIP"
Joy Mfg. Co.
Ledeen, Inc.
Owatonna Tool Co.
Schroeder Brothers Corp.
Vickers Incorporated

HYDRAULIC CYLINDERS, PUMPS, VALVES, REBUILT

Leman Machine Co.

HYDRAULIC FLUID

The American Oil Co.
The Atlantic Refining Co.,—"EUREKA," "HYTHERM," "IDEAL"
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Esso Standard, Div. of Humble Oil and Refining Co.—"TERESSO," "ESSTIC," "NUTO," "NURAY," "CORAY," "UNIVIS"
Hulburt Oil & Grease Co.—"HULBURT 11AA, 11A, 11AAA, No. 26, No. 27"
Keenan Oil Co.
Keystone Lubricating Co.
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sinclair Refining Co.—"DURO"
Sun Oil Co.—"SOLNUS," "SUNTAC," "SUNVIS" "MINETAC," "SUNVIS" "MINESAFE" (new)
Texaco, Inc.—"RECAL OIL R&O," "RANDO OILS"

HYDRAULIC FLUID, USBM FIRE-RESISTANT

The Atlantic Refining Co., "HYDRAULIC FRC"
Hulburt Oil & Grease Co.—"HUL-E-MUL"
Monsanto Chemical Co.—"PYDRAUL SERIES"
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.—"SHELL 3XF MINE FLUID"
Sinclair Refining Co.—"DURO-F-R"

HYDRAULIC MAINTENANCE KITS

Blackhawk Industrial Div.

HYDRAULIC POWER UNITS

Hunt Valve Co., Div of IBEC—"HYQUIP"
Schroeder Brothers Corp.

HYDRAULIC PUMPS

AE Industrial Div., Aircraft Armaments Inc. "HELE-SHAW," "HYRA-MITE"
Blackhawk Industrial Div.
De Laval Steam Turbine Co.—"IMOY"
Denison Engineering Div., American Brake Shoe Co.
Gar Wood Industries, Inc.
General Equipment & Manufacturing Co.
Hydreco Div., The New York Air Brake Co.—"HYDRECO"
Joy Mfg. Co.
National Mine Service Co.
Owatonna Tool Co.
Schroeder Brothers Corp.
Vickers Incorporated
Worthington Corp.

HYDRAULIC PUMPS, REBUILDING, REPAIR

Meckum Engineering, Inc.
West Virginia Armature Co.

HYDRAULIC REPAIR SERVICE

Flood City Brass & Electric Co.

HYDRAULIC VALVES

Blackhawk Industrial Div.
A. W. Cash Co.
Denison Engineering Div., American Brake Shoe Co.
Hunt Valve Co.—"QUICK-AS-WINK"
Hydreco Div., New York Air Brake Co.—"HYDRECO"
Ledeen, Inc.
Parker Hydraulic Div., Parker-Hannifin Corp.—"PARKER"
Schroeder Brothers Corp.
Vickers Incorporated
Walworth Co.

HYDROSEPARATORS

Denver Equipment Co.—"DENVER," "HYDRO-CLASSIFIER"
Dorr-Oliver, Incorporated
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company Inc.
WEMCO DIV., Western Machinery Co.—"WEMCO"

IMPACT TOOLS—See Drills, Roof-Bolting, Rotary Impact Tools for

INDICATING LIGHTS

Cutler-Hammer, Inc.—"PRESTEST"

INDICATORS, REMOTE

Allis-Chalmers Mfg. Co.
B-I-F Industries, Inc.
The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Hays Corp.
Hewitt-Robins Incorporated
Industrial Physics & Electronics Co.

INDICATORS, SPEED, ELECTRIC

Reliance Electric and Eng. Co.

INITIATORS, AMMONIUM NITRATE-FUEL-OIL BLASTING AGENTS—See Boosters, Ammonium-Nitrate

Propellex Chemical Div., Chromalloy Corp.—"SAF-T-BOOST"

INSTRUMENTS, BLASTING-VIBRATION

W. F. Sprengnether Instrument Co., Inc.

INSTRUMENTS, RECORDING PRESSURE, TEMPERATURE, ETC.

B-I-F Industries, Inc.—"FLO-WATCH," "CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
Hays Corp.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
West Instrument Corp.—"MARKSMAN"

INSTRUMENTS, ROOF-CONTROL

Herold Mfg. Co.

INSULATING MATERIALS, ELECTRICAL

Dow Corning Corp.
Duquesne Mine Supply Co.
General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept.
Irvington Div. of Minnesota Mining & Mfg. Co.
Johns-Manville—"FIBROID" "ARMATURO," "QUINTERRA," "QUINTERRABORD" "QUINORGO," "QUINORGOBORD" "ASBESTOS" "EBONY," "OHMSTONE"
Keasbey & Mattison Co.
Minnesota Mining & Mfg. Co.—"SCOTCHFIL," "SCOTCH CAST" BRAND RESIN
National Electric Coil Div. of McGraw-Edison Co.
Pennsylvania Electric Coil Corp.
Shell Oil Co.—"SHELL DIALA-OIL AX"
West Virginia Armature Co.

INSULATING MATERIALS, HEAT & COLD

Bigelow-Liptak Corp.
Philip Carey Mfg. Co.—"MAGNESIA," "HI-TEMP," "CAREY-TEMP," "AIRCELL," "IMPERVO," "PERFECTO"
Dow Corning Corp.
Johns-Manville—"SUPER-EX," "ASBESTO-SPONGE," "THERMOBESTOS," "ROCK CORK," "ZEROLITE," "FIBROCEL" "THERMO-FLEX," "ASBESTOCEL," "SPINTEX," "BANROC" "MICROLITE" "MICROTEX," "MICRO-LOK," "METAL-ON"
Keasbey & Mattison Co.
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp. "PLASTIC," "VEE-BLOCK CASTABLE," "M-5," "I-R-C"
Pittsburgh Corning Corp.—"FOAMGLAS" "FOAM-THANE"
Pittsburgh Plate Glass Co.—"PPG FIBER GLASS" "SELECTROFOAM"
The Ruberoid Co.
G. C. Thomas Mfg. Co.
United States Rubber Co.

INSULATING MATERIALS, NOISE

Johns-Manville "SPIN COUSTIC," "SANACOUSTIC," "PERMACOUSTIC," "FIBRETONE," "MICROLITE," "MICRO-BAR," "PANELGLAS,"
Keasbey & Mattison Co.—"SPRAYED LIMPET," "ASBESTOS"
Minnesota Mining & Mfg. Co.—"SCOTCH" BRAND
Pittsburgh Plate Glass Co.—"PPG FIBRE GLASS" "SELETROFOAM"
United States Rubber Co.

INSULATORS, ELECTRIC

Albert & J. M. Anderson Mfg. Co.
Delta-Star Electric Div., H. K. Porter Co., Inc.
The Elreco Corp.
I-T-E Circuit Breaker Co.
Ohio Grass Co.

INSULATORS, RUBBER

Automatic Vulcanizing Corp.

INSULATORS, SECTION

The Elreco Corp.—"ELRECO"

INSURANCE, CASUALTY, WORKMEN'S COMPENSATION

Bituminous Casualty Corp.
J. B. Pfister Co.
Reliance Insurance Co.

INSURANCE, PLANT & EQUIPMENT

J. B. Pfister Co.
Reliance Insurance Co.

INSURANCE, SELF PROGRAMS

J. B. Pfister Co.

INVERTERS & CONVERTERS

Perkin Electronics Corp. (DC to AC)

INVESTMENT BANKERS

Dominick & Dominick

INVESTMENT GUIDANCE

F. S. Smithers & Co.

IRON OXIDE

Foote Mineral Co.—"MAGNA-FLOAT"

J-HOOKS, INSULATED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"

J-HOOKS, NON-INSULATED

The Elreco Corp.—"ELRECO"

JACKLEGS, PNEUMATIC

Chicago Pneumatic Tool Co.
Schroeder Brothers Corp.

JACK-PIPE

Duquesne Mine Supply Co.

JACKS, AIR-OPERATED

Duff-Norton Co.
Joyce Cridland Co.

JACKS, AIR, ELECTRICALLY, GASOLINE-OPERATED

Templeton, Kenly & Co. — "REMOTROL"

JACKS, ANCHOR OR HOLD DOWN

Templeton, Kenly & Co.

JACKS, BELT-TENSIONING

Templeton, Kenly & Co. — "SIMPLEX"

JACKS, GEARED

Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co. — "SIMPLEX"

JACKS, HYDRAULIC

Aro Equipment Corp.
Blackhawk Industrial Div.
Duff-Norton Co.
Mining Progress, Inc.
National Mine Service Co.
H. K. Porter, Inc.
Templeton, Kenly & Co. — "SIMPLEX"

JACKS, MECHANICAL

Blackhawk Industrial Div.

JACKS, PULLING

Armstrong, Bray & Co. — "STEELGRIP"
Duff-Norton Co.
Gibraltar Equipment & Mfg. Co.
Joyce Cridland Co.
National Mine Service Co.
Templeton, Kenly & Co. — "JENNY," "CENTER-HOLE"
Transall, Inc.

JACKS, PUSH & PULL

Armstrong, Bray & Co. — "STEELGRIP"
Blackhawk Industrial Div.
Duff-Norton Co.
Gibraltar Equipment & Mfg. Co.
Joyce Cridland Co.
National Mine Service Co.
H. K. Porter, Inc.
Templeton, Kenly & Co. — "SIMPLEX"

JACKS, RACHET LIFTING, LOWERING

Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.

JACKS, RACHET LOWERING

Templeton, Kenly & Co. — "SIMPLEX"

JACKS, REEL

Templeton, Kenly & Co. — "SIMPLEX"

JACKS, ROOF

Duff-Norton Co.
Duquesne Mine Supply Co.
Herold Mfg. Co.
Mining Progress, Inc.
National Mine Service Co.
Templeton, Kenly & Co. — "SIMPLEX"

JACKS, ROOF, HYDRAULIC

Templeton, Kenly & Co. — "SIMPLEX"

JACKS, ROOF BOLT RECOVERY

Templeton, Kenly & Co. — "SIMPLEX"

JACKS, SCREW

Duff-Norton Co.
Joyce Cridland Co.
Ensign Electric & Mfg. Co.
Templeton, Kenly & Co. — "SIMPLEX"

JACKS, TIMBERING

Duff-Norton Co.
Ensign Electric & Mfg. Co.
Herold Mfg. Co.
Mining Progress, Inc.
Templeton, Kenly & Co. — "SIMPLEX"

JACKS, TRACK

Templeton, Kenly & Co.

JETS, OVERFIRE, SMOKE CONTROL

Canton Stoker Corp.—"TURBO-AIRE"

JIG SAWS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.

JIGS, PYRITE RECOVERY

Denver Equipment Co. — "DENVER," "SELECTIVE MINERAL"

JOINT COMPOUND, ALUMINUM CABLE

The Elreco Corp.

JOINTS, EXPANSION, RUBBER, TEFLON

Garlock Inc.

JOINTS, HIGH PRESSURE AND TEMPERATURE

Marman Div., Aeroquip Corp. — "LIVE JOINT"

JOINTS, SWIVEL

Chiksan Co.

JOURNAL BOXES, REBUILT

Leman Machine Co.

JOURNALS, BOXES

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Chain Belt Co.—"SHAFER-REX"
Enterprise Wheel and Car Corp.
Flood City Brass & Electric Co.
Helmick Foundry-Machine Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
West Virginia Armature Co.

JUNCTION BOXES ELECTRIC, STRIPPING

Atkinson Armature Works
Crouse-Hinds Co.
Joy Mfg. Co.

JUNCTION BOXES ELECTRIC, UNDERGROUND

Albert & J. M. Anderson Mfg. Co.—"POW-R-GARD," "GROUND-GARD"
Crouse-Hinds Co.
Ensign Electric & Mfg. Co.
Joy Mfg. Co.
National Electric Div. H. K. Porter Co., Inc.
Ohio Brass Co.
Schroeder Brothers Corp.

KNEE PADS

General Scientific Equipment Co. —"GS"
Industrial Rubber Products Co.—"ROCK-MASTER"
Judsen Rubber Works, Inc.
Mine Safety Appliances Co.
Mining Progress, Inc.
National Mine Service Co.
Pulmosan Safety Equip. Co.

KNOCK OUT PUNCHES, HYDRAULIC

Blackhawk Industrial Div.

KW, KWRA, KVA, RKVA METERS

The Bristol Co.—"BRISTOL'S"
Westinghouse Electric Corp.

LABORATORY EQUIPMENT

Bausch & Lomb Inc.
Central Scientific Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
The Galigher Co.
Holmes Bros., Inc.
Laboratory Equipment Corp. — "LECO"
Sturtevant Mill Co.
W. S. Tyler Co.

LABORATORY EQUIPMENT, COAL DRYING

Link-Belt Co., Dept. CAMGL-61

LABORATORY TESTING

Commercial Testing & Engineering Co.
Denver Equipment Co. — "DENVER"
The Galigher Co.
Southwestern Engineering Co. — "SWECO"
Sturtevant Mill Co.
Wemco Div., Western Machinery Co.—"WEMCO"

LACING, BELT

Armstrong-Bray & Co.—"STEELGRIP," "SAFETY," "WIREGRIP"
Crescent Belt Fastener Co. (Plates & Rivets)—"CRESCENT"
General Splice Corp.—"MINET"

LAMPS, PICKING

General Electric Co., Lamp Div. —"GENERAL ELECTRIC"
Mosebach Elec. & Supply Co.

LARRIES

Chain Belt Co.—"REX"
Connellsville Corp.
Differential Steel Car Co.
Irwin Sensenich Corp.
Link-Belt Co., Dept. CAMGL-61
Stephens-Adamson Mfg. Co.

LARRIES, WEIGH

Link Belt Co., Dept. CAMGL-61

LATEX

B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated

LEADING WIRE

Hercules Powder Co.

LEVELS, ENGINEERS

C. L. Berger & Sons, Inc.—"BERGER"
Gurley, W. & L. E.
Kern Instruments, Inc.

LEVELS, ROD

Kern Instruments, Inc.

LEVELS, TRACK

The Aldon Co.

LIGHTING, EMERGENCY

American Optical Co., Safety Products Div.—"SENTRY-LITE"
Exide Industrial Marketing Div., The Electric Storage Battery Co.—"EXIDE LIGHTGUARD"

LIGHTING, PORTABLE, PREFABRICATED

Joy Mfg. Co.—"STRING-O-LITE"

LIGHTING FIXTURES

Crouse-Hinds Co.
Phoenix Products Co., Inc.
Westinghouse Electric Corp.

LIGHTING FIXTURES, UNDERGROUND

Femco, Inc.
Mine Safety Appliances Co.—"M-S-A FLUORESCENT"

LIGHTING SETS, LOW-VOLTAGE

Joy Mfg. Co.

LIGHTNING ARRESTERS

Delta-Star Electric Div., H. K. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
Ohio Brass Co.
Westinghouse Electric Corp.

LIGHTNING ARRESTERS, HIGH-VOLTAGE

Ohio Brass Co.—"THOREX"

LINER PLATE, CHUTES CONVEYORS, ETC.

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Armco Drainage & Metal Prod., Inc.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates

LINER PLATE, SHAFT & TUNNEL

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Commercial Shearing & Stamping Co.
Republic Steel Corp.—"TRUSCON"

LININGS, CHUTE, CERAMIC

Bigelow-Liptak Corp.

LININGS, CHUTE & FLUME

Linco Co.
Stonhard Co. Inc.—"STON-PACH"

LININGS, CHUTE, GLASS

Pittsburgh Plate Glass Co.—"CARRARA"

LININGS, CHUTE, METAL

American Manganese Steel Div.,

American Brake Shoe Co.—"AMSCO"
The Daniels Co.
Enterprise Wheel and Car Corp.
Illinois Zinc Co., Div. of Hydrometals
Kanawha Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Laubenstein Mfg. Co.
Remaly Mfg. Co., Inc.
Stulz-Sickles Co.—"MANGA-NAL"

LININGS, CHUTE, RUBBER
Acme-Hamilton Mfg. Corp.
American Biltrite Rubber Co.
Boston Woven Hose & Rubber Co.—"BOSTON"
The Galigher Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Linatex Corp. of America
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

LININGS CHUTE, RUBBER, PLAIN & METAL BACKED
B. F. Goodrich Industrial Products Co.

LININGS, CONCRETE
Bigelow-Liptak Corp.
Allentown Pneumatic Gun Co.—Pneumatic Gunning
Sika Chemical Corp.—"PLASTIMENT CONCRETE DENSIFIER"

LININGS, FURNACE
Bigelow-Liptak Corp.
Allentown Pneumatic Gun Co.—Pneumatic Gunning
Joseph Dixon Crucible Co.
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.

LININGS, SHEET,; CONCRETE AND STEEL
Amercoat Corp.—"AMER-PLATE" "T-LOCK AMER-PLATE," "NOB-LOCK"

LININGS, TANK
Allentown Pneumatic Gun Co.—Pneumatic Gunning
Enterprise Wheel and Car Corp. (metal)
Linco Co.
Pittsburgh Plate Glass Co.—"CARRARA & HERCULITE" (glass)

LININGS, TANK FLUOROCARBON
Garlock Inc.

LININGS, TANK, RUBBER
Denver Equipment Co. — "DENVER"
The Galigher Co.
The Gates Rubber Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Linatex Corp. of America
Magichemical Co.—"MAGI-VULC"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

LINKS, INSULATED SAFETY
E. D. Bullard Co.

LIQUIDS, REFLECTIVE
Minnesota Mining & Mfg Co.—"CODIT" BRAND

LOAD SUSPENSION, RUBBER, FOR MINE CARS
National Castings Co.

LOADERS, CRAWLER-MOUNTED
Allis-Chalmers Mfg. Co.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div. "LIMA"
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.—"TRAX-CAVATORS"
The Eimco Corp.
International Harvester Co.—"SKID-SHOVEL"
Koehring Div. of Koehring Co.
Mining Progress, Inc.
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAT"

LOADERS, PORTABLE, BELT, BUCKET
Barber-Greene Co.
Gruendler Crusher & Pulverizer Co.
Irwin-Sensenich Corp.
Lippmann Engineering Works Inc.
Pettibone Mulliken Corp., Haiss Div.
Stephens-Adamson Mfg. Co.

LOADERS, REVOLVING-TYPE—See "Shovels, revolving"

LOADERS, SELF PROPELLED BELT
Athey Products Corp.
Link-Belt Co., Dept. CAMGL-61—"JETSLINGERS"

LOADERS, TRACTOR-MOUNTED
Allis-Chalmers Mfg. Co.
Caterpiller Tractor Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
The Eimco Corp.
Goodman Mfg. Co.
Hyster Co.
International Harvester Co.
Morse Bros. Machinery Co.

LOADERS, TRACTOR-MOUNTED REBUILT
Leman Machine Co.

LOADERS, UNDERGROUND—See "Loading Machines"

LOADERS, WHEEL-MOUNTED
Caterpillar Tractor Co.—"TRAX-CAVATORS"
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
The Eimco Corp.
Euclid Div., General Motors Corp.
The Frank G. Hough Co.—"PAYLOADER"
Koehring Div. of Koehring Co.
Sanford-Day Corp.—"TRANS-LOADER"
The Thew Shovel Co.—"LORAIN MOTO-LOADER"

LOADING BOOMS, APRON
Galis Electric & Machine Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Company Didivision of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co. Inc.

LOADING BOOMS, BELT
Galis Electric & Machine Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.
G. C. Thomas Mfg. Co.
Webster Mfg. Co. Inc.

LOADING BOOMS, CHAIN
Galis Electric & Machine Co.
Helmick Foundry-Machine Co.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Webster Mfg. Co. Inc.

LOADING BOOMS, CHAIN RESCREENING
Galis Electric & Machine Co.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

LOADING-MACHINE CHECKS
Daly Ticket & Printing Co.—"DALY'S"

LOADING MACHINES, REBUILT
Leman Machine Co.

LOADING MACHINES, UNDERGROUND, CRAWLER
The Eimco Corp.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Long-Airdox Co.—"MODEL 88," "MODEL 188"
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"

LOADING MACHINES, UNDERGROUND RUBBER-TIRED
Jeffrey Mfg. Co.

LOADING MACHINES, UNDERGROUND, CONVERTED TRACK TO RUBBER
Lee-Norse Co.

LOADING MACHINES, UNDERGROUND TRACK-MOUNTED
The Eimco Corp.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Mining Progress, Inc.
Myers-Whaley Co.—"WHALEY AUTOMAX"

LOADING STICKS, LOCK-HOOK
G. R. Johnson Loading Supplies

LOCATORS, TRAILING-CABLE FAULT
General Equipment & Manufacturing Co.
Ohio Brass Co.

LOCKERS
Miners Hardware Supply Co.—"LYON METAL PRODUCTS"
Republic Steel Corp.—"REPUBLIC STEEL"

LOCKERS, OVERHEAD
The Moore Co.—"LOCKERBASKETS"

LOCK BOLTS, NYLON
Republic Steel Corp.

LOCK NUTS
Bearings, Inc.
Elastic Stop Nut Corp. of America—"ELASTIC STOP NUTS"
Link-Belt Co., Dept. CAMGL-61
National Electric Div. H. K. Porter Co., Inc.
The Palnut Co.—"PALNUT," "PAL"
Republic Steel Corp.—"REPUBLIC NYLOK"

LOCOMOTIVES, BATTERY
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
The Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Kersey Manufacturing Co., Inc.
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.
Morse Bros. Machinery Co.
National Mine Service Co.—"GREENSBURG"

LOCOMOTIVES, CABLE-REEL
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.

LOCOMOTIVES, DIESEL-ELECTRIC
Differential Steel Car Co.
Fairbanks Morse & Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH"

LOCOMOTIVES, DIESEL HYDRAULIC
General Electric Co., Locomotive & Car Equipment Dept.

LOCOMOTIVES, DIESEL, SURFACE
Brookville Locomotive Works
Fairbanks Morse & Co.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQOMOTIVE"

LOCOMOTIVES, DIESEL, UNDERGROUND
Mancha Storage Battery Locomotive Div., Goodman Mfg. Co.
National Mine Service Co.—"GREENSBURG"
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH MINE-O-MOTIVE"

LOCOMOTIVES, GASOLINE, SURFACE
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQUOMOTIVE"

LOCOMOTIVES, REBUILT
Leman Machine Co.

LOCOMOTIVES, RUBBER TIRED
General Electric Co., Locomotive & Car Equipment Dept.

LOCOMOTIVES, TROLLEY
Differential Steel Car Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
The Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Mancha Storage Battery Locomotive, div. Goodman Mfg. Co.
Morse Bros. Machinery Co.
National Mine Service Co.—"GREENSBURG"
West Virginia Armature Co.

LUBRICANT METERS
Stewart Warner Corp., Alemite Div.

LUBRICANTS
American Oil Co. Ashland Oil & Refining Co.—"VALVOLINE-ASHLAND"
Atlantic Refining Co.
Bearings Inc.—"LUBRIKO"
The Brooks Oil Co.—"LEAD-OLENE," "KLINGFAST"
Samuel Cabot, Inc.—"CABOT's TASGON," "CABOT's LUBRI-TASGON"
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Joseph Dixon Crucible Co.
Dow Corning Corp.
Esso Standard, Div. of Humble Oil and Refining Co.—"P.U.C. O-LED EP," "DIOL DX-130," "CYLESSO," "CANTHUS," "ROXTONE," "AROX EP," "NEBULA EP," "ANDOK," "ESTAN," "CAZAR," "CO-MAL," "NAKTA," "SURETT"
Gulf Oil Corp.
Hulburt Oil & Grease Co.—"HULBURT 17, 320"
Keystone Lubricating Co.
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
New York & New Jersey Lubricant Co.—"NON-FLUID OILS"
Ohio Oil Co.
Pennsylvania Refining Co.
The Pure Oil Co.—"POCO PB GEAR LUBRICANTS"
Shell Oil Co.
Sinclair Refining Co.—"JET," "ONYX," "OPALINE MP"
Stewart-Warner Corp., Alemite Div.
Sun Oil Co.—"SOLNUS," "SUN-TAC," "SUNVIS," "SUN 740A-EP LUBRICANT," "PRESTIGE 740-A EPUNI VERSAL MINING-MACHINE LUBRICANT"
Texaco Inc.
Tidewater Oil Co.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.—"VALVO-LINE"
Warren Refining & Chemical Co.—"PLASTILUBE," "BUS-TRUX," "PLASTIGEAR," "GREEN GOLD," "WARCO," "STAYSIN," "LITHOLUBE"
The Whitmore Mfg. Co.—"WHITEMORES PRESSURE-PROOF"

LUBRICANTS, AIR COMPRESSOR, FIRE-RESISTANT
Monsanto Chemical Co.—"PY-DRAUL AC"

EXPANDING in SERVICES and PRODUCTS

For the Mining Industries

National Mine
Service Company

Seven major products distributed and serviced exclusively by National Mine

National Mine TorKar

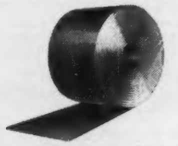
With operation based on a single prime-mover and torque converter, AC, DC and Diesel-Powered TorKars are establishing new standards of shuttle car performance, with sharply reduced maintenance.

Greensburg ManKar

A complete line of Greensburg ManKar Personnel Carriers for fast, safe, comfortable transportation to work areas; Utility and Officials' Cars; all types of Greensburg battery, trolley, diesel locomotives—2 to 15 tons.

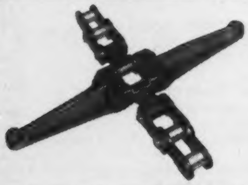
Wheat National Electric Cap Lamp

A major advance in better light for the miner, incorporating significant new developments in battery, bulb and fingertip focussing—resulting in better light, greater utility, better service.



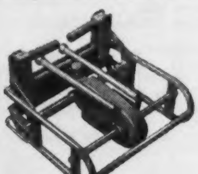
Scandura Belting

Stronger, lighter and more durable, fire-resistant P.V.C. Scandura is best for the long haul; best for extensibles! More productive because it stays on the job without expensive repair.



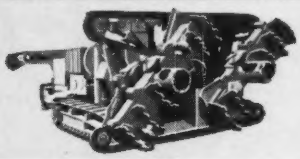
Clarkson Redbird Conveyor Chains

The leader in conveyor chain performance, with balanced construction providing longer, trouble-free service. Welded flight assembly lessens wear and strain, eliminates need for adjustment. A Clarkson Division product.



Hayden Belt Fastening Equipment

New, compact design for easy conveyor belt splicing even in extremely thin seams. Convenient portability, one-man operation; handles all thicknesses, widths and types of belt. Wide hook range, spring-loaded clamping, constructed for rugged mine service.



Marietta Continuous Miner

This is a rugged, powerful, caterpillar-mounted, boring-type continuous mining machine of proven high capacity in coal and non-metallic mining—built by National Mine's Clarkson Division.

NATIONAL MINE SERVICE COMPANY

Koppers Building · Pittsburgh 19, Pa.

National Mine Service (Canada) Limited, Elliot Lake, Ontario

(2) MANUFACTURING DIVISIONS

(9) DISTRIBUTING DIVISIONS

LUBRICANTS, ROCK DRILL
Atlantic Refining Co.
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Sun Oil Co.

LUBRICATING FITTINGS
Aro Equipment Corp.
Gray Co. Inc.
Lincoln Engrg. Co., Div. of Mc-Neil Mach. & Engrg. Co. — "BULLNECK"
Stewart-Warner Corp., Alemite Div.

LUBRICATING GUNS
Aro Equipment Corp.
Joseph Dixon Crucible Co.
Gibraltar Equipment & Mfg. Co. —"FRICTION DOCTOR"
Gray Co., Inc.
Lincoln Engrg. Co., Div. of Mc-Neil Mach. & Engrg. Co.
Stewart-Warner Corp., Alemite Div.

LUBRICATING PUMPS
Stewart-Warner Corp., Alemite Div.

LUBRICATING SYSTEMS, CONTINUOUS
Farval Div., Eaton Mfg. Co.
Gray Co., Inc.
Lincoln Engrg. Co., Div. of Mc-Neil Mach. & Engrg. Co.— "MULTILUBER"
Manzel unit of Houdaille Industries, Inc.
Nathan Mfg. Div., Wegner Machinery Corp.—"NATHAN," "A," "P"
Stewart-Warner Corp., Alemite Div.—"OIL-MIST"
Trabon Engr. Corp.
Trico Fuse Mfg. Co.—"TRICO"

LUBRICATING SYSTEMS, CENTRALIZED
Farval Div., Eaton Mfg. Co.
Lincoln Engrg. Co., Div. of Mc-Neil Mach. & Engrg. Co. — "CENTRO-MATIC," "CENTRO-LUBER," "CENTROILER"
Manzel unit of Houdaille Industries, Inc.
Nathan Mfg. Div., Wegner Machinery Corp.—"NATHAN," "A," "P"
Stewart-Warner Corp., Alemite Div.—"ACCUMATIC"
Trabon Engrg. Corp.
Trico Fuse Mfg. Co.—"TRICO"

LUBRICATING SYSTEMS, CIRCULATING OIL
Trabon Engr. Corp.—"METER-FLO"

LUBRICATING SYSTEMS, MANUAL
Farval Div., Eaton Mfg. Co.

LUBRICATING SYSTEMS, OIL MIST
Trabon Engr. Corp.—"METER-MIST"

LUBRICATING SYSTEMS, SPRAY, MANUAL, AUTOMATIC
Farval Div., Eaton Mfg. Co.

LUBRICATORS
Hunt Valve Co.—"QUICK-LUBE"

LUBRICATORS, WHEEL FLANGE, "TYPE MS"
Nathan Mfg. Div., Wegner Machinery Corp.
Transall, Inc.

LUBRICATORS, JOURNAL-BEARING
American Brake Shoe Co., Railroad Products Div.
Aro Equipment Corp.

LUBRICATORS, RAIL
American Brake Shoe Co., Railroad Products Div.

LUMBER, TREATED
Koppers Co., Inc., Wood Preserving Div. (creosoted)—"WOLMANIZED"
T. J. Moss Tie Co.
Republic Creosoting Co., Div. of Reilly Tar & Chemical Corp.

MACHINE GUARDS, PARTS FOR
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.

MACHINES, CUSTOM-BUILT
National Mine Service Co.

MAGNET WIRE
Crucible Steel Co. of America
General Electric Co., Wire and Cable Dept.
Rome Cable, Div. of Alcoa

MAGNETITE
The Daniels Co.
Orefraction, Inc.

MAGNETITE RECOVERY DENSIFIERS
Mine and Smelter Supply Co.— "AKINS"
WEMCO Div., Western Machinery Co.—"WEMCO"

MAGNETITE RECOVERY SEPARATORS
The Daniels Co.
Dings Magnetic Separator Co.
Eriez Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MAGNETS, CHUTE-TYPE
Dings Magnetic Separator Co.
Eriez Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MAGNETS, DRUM TYPE
Magnetic Engineering & Mfg. Co.

MAGNETS, PERMANENT
Crucible Steel Co. of America — "FERRIMAG ," "ALNICO"
Metallurgical Products Dept., General Electric Co.—"ALNICO"
Stackpole Carbon Co. — "CERAMAGNET"

MAGNETS, PERMANENT, CHUTE, PULLEY, SUSPENDED
Dings Magnetic Separator Co.
Eriez Mfg. Co.
The Homer Mfg. Div., The Ohio Electric Mfg. Co.—"HOMER"
Magnetic Engrg. & Mfg. Co.
W. J. Savage Co.
Stearns Magnetic Products
Transall, Inc.

MAGNETS, PLATE TYPE
Dings Magnetic Separator Co.

MAGNETS, PULLEY-TYPE
Dings Magnetic Separator Co.
Eriez Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MAGNETS, SUSPENDED
Dings Magnetic Separator Co.
Eriez Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MAINTENANCE SETS
Owatonna Tool Co.

MALLEABLE IRON, ALUMINUM
Eastern Sales Co., Div. of The Eastern Co.

MAPS, TOPOGRAPHIC, PHOTOGRAPHIC
Aerial Surveys, Inc.
Aero Service Corp.
American Air Surveys, Inc.
Jack Ammann, Inc. Engineers & Surveyors

MASKS, DUST
Flexo Products, Inc.—"FLEX-A-FOAM"
Martindale Electric Co.

METAL SPRAY EQUIPMENT
Wall Colmonoy Corp.—"SPRAY WELDER"

METALLIZING WIRE
Crucible Steel Co. of America

METERS
Analytical Measurements, Inc.

METERS, ELECTRICAL— See Ammeters, Etc.

METERS, WATER, VENTURI
Infilco Inc., Gale Separator Div.— "TWIN-THROAT"

MICA MAT
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

MICA, BUILT-UP
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

MICROSCOPES
Bausch & Lomb Inc.
Fisher Scientific Co.
Wild Heerbrugg Instruments Inc.

MILLISECOND CONNECTORS FOR DETONATING FUSE
E. I. du Pont de Nemours & Co., Inc.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Trojan Powder Co.

MILLS, BOWL, IMPACT, SCREEN, VERTICAL
Combustion Engineering, Inc. — "C-E-RAYMOND"

MILLS, LABORATORY
American Pulverizer Co.
Central Scientific Co.
Combustion Engineering, Inc. — "C-E-RAYMOND"
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Sturtevant Mill Co. (including micronizer grinding machine)

MINE TIES—See Rail Ties

MOILS
Howells Mining Drill Co.

MOISTURE-BARRIER PAPER
Fulton Cotton Mills

MOISTURE METERS
The Bristol Co.—"THERMO-HUMIDIGRAPH"
Heyl & Patterson, Inc.—"OLIVO"
Industrial Physics & Electronics Co.

MOISTURE TESTERS
Analytical Measurements, Inc.

MORTAR, REFRACTORY
Johns-Manville—"SIL-O-CEL"
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"LO-SET," "MEX-LOX," "MILL MORTAR," "BOND SET," "HILOSET," "SUPER HILOSET," "KAISER 91," "KAISER 96"
Norton Co.
H. K. Porter Co., Refractories Dept.

MOTOR BASES
The American Pulley Co. — "SECONO-MATIC"

MOTOR CONTROL CENTERS
Allis-Chalmers Mfg. Co.
Cutler-Hammer Inc. — "UNI-TROL"

MOTOR CONTROLLERS, STARTERS
Allis-Chalmers Mfg. Co.
Arrow Hart & Hegeman Electric Co.
Clark Controller Co.
Cutler-Hammer, Inc.—"C-H"
Electric Machinery Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.
Ohio Brass Co.
W. J. Savage Co.
Schroeder Bros. Corp.
Westinghouse Electric Corp.

MOTOR-GENERATOR SETS
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
Allis-Chalmers Mfg. Co.
The Louis Allis Co.
Electric Products Co.
Electro Dynamic Div. of General Dynamics Corp.
Elliott Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons — "HANCO"
Hobart Bros. Co.
Joy Mfg. Co.
The Lincoln Electric Co.— "SHIELD-ARC"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Morse Bros. Machinery Co.
Reliance Elec. & Eng. Co.
Robbins & Myers, Inc.—"R & M"
Westinghouse Electric Corp.

MOTOR REWINDING, REPAIRS
Flood City Brass & Electric Co.
F. R. Hannon & Sons — "HANCO"
Joy Mfg. Co.
National Electric Coil Div. of McGraw-Edison Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

MOTORS, AC
Allis-Chalmers Mfg. Co.
The Louis Allis Co.
J. D. Christian Engineers
Dooley Brothers
Electric Machinery Mfg. Co.
Electric Products Co.
Electro Dynamic Div. of General Dynamics Corp.
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks Morse & Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons — "HANCO"
Joy Mfg. Co.
The Lincoln Electric Co. — "MULTIGUARD"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Reliance Elec. & Eng. Co.
Robins & Myers, Inc—"R & M"
W. J. Savage Co.
Schroeder Brothers Corp.
Sterling Electric Motors, Inc., A Sub. of Hathaway Instruments, Inc.
U. S. Electrical Motors Inc. — "UNICLOSED," "VARI-DRIVE," "SYNCROGEAR"
Wagner Electric Corp.
Westinghouse Electric Corp.

MOTORS, AIR
Chicago Pneumatic Tool Co.
Eimco Corp.
Gardner-Denver Company
Joy Mfg. Co.—"TURBINAIR PISTONAIR"
Ingersoll-Rand Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

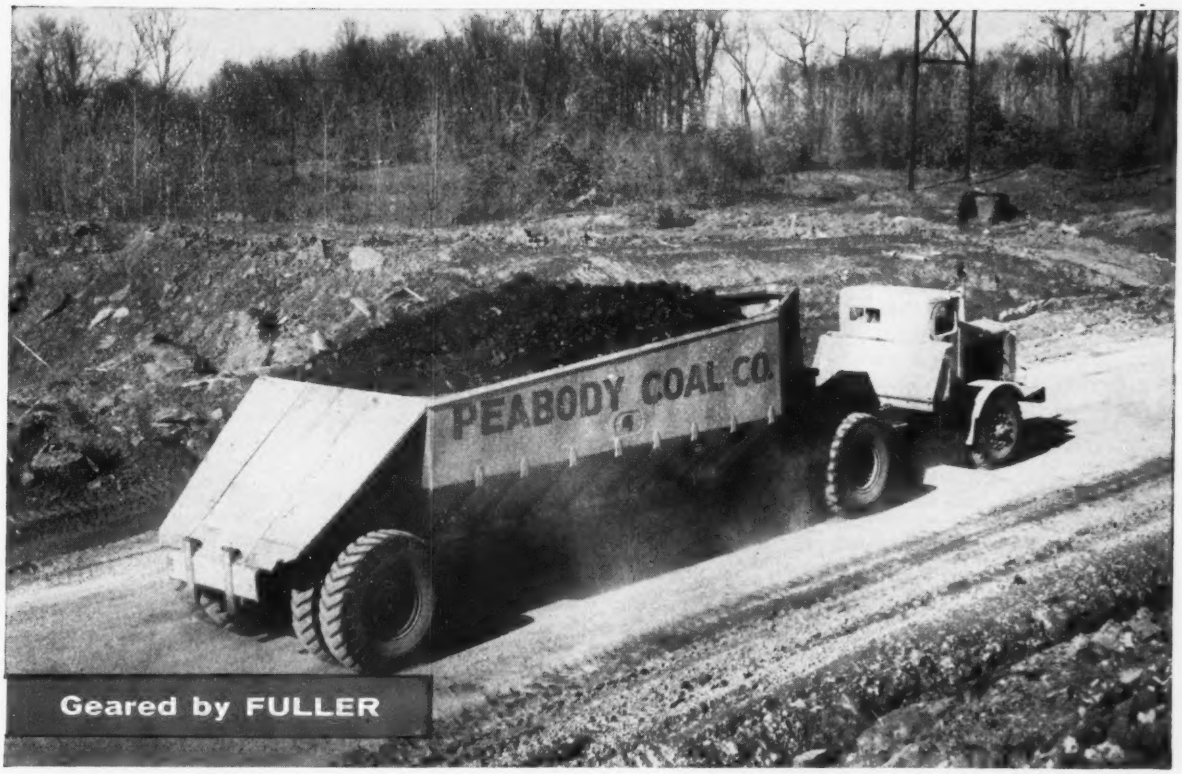
MOTORS, DC
Allis-Chalmers Mfg. Co.
The Louis Allis Co.—"FLEXI-TORY"
J. D. Christian Engineers
Dooley Brothers
Electric Products Co.
Electro Dynamics Div. of General Dynamics Corp.
Elliott Co.
Ensign Electric & Mfg. Co.
Fairbanks Morse & Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons — "HANCO"
Joy Mfg. Co.
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Reliance Elec. & Eng. Co.
Robbins & Myers Inc.—"R & M"
W. J. Savage Co.
Schroeder Brothers Corp.
Westinghouse Electric Corp.

MOTORS, FLUID
Link-Belt Co., Dept. CAMGL-61 —"ELECTROFLUID"
The Master Electric Co., Div. of Reliance Electric & Eng. Co.
Schroeder Brothers Corp.

MOTORS, GEAR
Link-Belt Co., Dept. CAMGL-61 —GEARMOTORS," "MOTO-GEARS"

MOTORS, HYDRAULIC
Hydreco Div., The New York Air Brake Co.—"HYDRECO"
Vickers, Incorporated

NAILS
American Steel & Wire Div., U.S. Steel Corp.—"AMERICAN"
Bethlehem Steel Co.
Jones & Laughlin Steel Corp.
Republic Steel Corp.



Peabody Coal Company of St. Louis, Missouri hauls 52-ton loads from their River King Mine in Illinois with *Fuller-equipped* Model 129TDT Euclid Tractors. These ten Euclid Tractors pull Model 124 Wagons with 61 cubic yard capacities. Engines in the Peabody Euclids are Cummins 350 hp V8 and NRTO 330 hp diesels and 12V71 336 hp Detroit Diesels. All drive through Fuller R-1160 ROADRANGER Transmissions and 14.96:1 axles.

Designed for Coal Hauling Equipment

Model R-1160 ROADRANGER Transmissions

Faster, smoother operation, greater fuel economy, faster cycles, and longer gear and bearing life are offered by the Fuller R-1160 ROAD-RANGER Transmission.

Check these advantages:

- No gear splitting—nine selective ratios evenly and progressively spaced (average of 38% steps).
- Easier, smoother shifting—one shift lever controls all nine forward and two reverse speeds.
- Pre-selected range shifts — automatic and synchronized, with range selector located on the shift lever.
- Quicker up shifts for constant operation in peak horsepower range — assured by Fuller air powered countershaft inertia brake.
- Prolonged gear and bearing life—Pressure Lubrication and Filtration System provides positive lubrication and maintains clean lubricating oil to prolong gear life.

Gear	Ratio	% Step	
9th	.75		
8th	1.00	33	HIGH RANGE
7th	1.39	39	Reverse 3.31
6th	1.94	40	
5th	2.59	34	
RANGE SHIFT			
4th	3.48		
3rd	4.84	39	LOW RANGE
2nd	6.76	40	Reverse 11.53
1st	9.02	34	

Weight: 1133 lbs. Length: 44 21/32"
Clutch Housing Size: SAE No. 1
Oil Capacity: 35 pts.; w/filter 38 pts.
Approximate Engine Size: 1160 cu. in.

FULLER TRANSMISSION DIVISION

EATON MANUFACTURING COMPANY

KALAMAZOO, MICHIGAN

Sales & Service: West. Dist. Branch, Oakland 6, Cal. • Southwest Dist. Office, Tulsa 3, Okla. • Automotive Products Co., Ltd., Brock House, Langham St., London W.1, England, European Rep.

NEWSLETTERS, FOREMEN

Elliott Service Co., Inc. — "MANAGEMENT INFORMATION"

NIBBLERS, PORTABLE ELECTRIC

The Black & Decker Mfg. Co.

NICKEL & NICKEL ALLOYS

Huntington Alloy Products Div., International Nickel Co., Inc.

NOZZLES, FOG

Bete Fog Nozzle, Inc.
The Fyr-Fyter Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
S. P. Kinney Engineers, Inc.

NOZZLES, SPRAY

Bete Fog Nozzle, Inc.
The Branford Co. — "BRANFORD"
Chain Belt Co.—"REX"
The Deister Concentrator Co., Inc.—"CONCENCO"
Deister Machine Co.
The Duriron Co., Inc.
The Fyr-Fyter Co.
Grinnell Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
The Johnson-March Corp.
S. P. Kinney Engineers, Inc.
Link-Belt Co., Dept. CAMGL-61 —"QUIK-CLAMP," "U-BOLT," "NONCLOGGING"
Spraying Systems Co.
West Virginia Armature Co.
Worthington Corp.

NOZZLES, WET ROCK DUSTING

American Mine Door Co.
Mine Safety Appliances Co.

NUTS

Bethlehem Steel Co.
Central Mine Supply Co. Div., Pickard Industries, Inc. — "PROTECTO"
The Palnut Co.—"PALNUT," "PAL"
Republic Steel—"REPUBLIC"
Sheffield Div., Armco Steel Corp.

NUTS, MINE ROOF BOLTS

Bethlehem Steel Co.
The Palnut Co.—"PALNUT," "PAL"

OFFICE FORMS

Daily Ticket & Printing Co.

OHMMETERS, MEGOHMMETERS

Martindale Electric Co.
Westinghouse Electric Corp.

OILS HYDRAULIC— See Hydraulic Fluids

OILS

Atlantic Refining Co.
Esso Standard Div. of Humble Oil & Refining Co.
Gulf Oil Corp., Dept. D.M.
Lubriplate Div., Fiske Bros. Refining Co.—"LUBRIPLATE"
Hulburt Oil & Grease Co.— "HULBURT 6 LIGHT SPECIAL COMPRESSOR"
Mobil Oil Co., A Div. of Socony-Mobil Oil Co., Inc.
New York & New Jersey Lubricant Co.
Pennsylvania Refining Co. — "SERIES 3," "H. D."
The Pure Oil Co.—"PURO-PALE RX," "SULTANA X HEAVY DUTY," "PUROPALE HYDRAULIC OILS," "PUROCO-HYDRAULIC OILS"
Sinclair Refining Co.—"TENOL," "RUBILENE," "PENNANT E. P."
Sun Oil Co.—"SOLNUS"

OPENERS, DOOR, FREIGHT CAR

The Aldon Co.

OUTDOOR STORAGE COVERS

Bemis Bro. Bag Co.

OVENS, INDUSTRIAL

Hevi-Duty Electric Co., A Div. of Basic Products Corp.

OVERCASTS, CORRUGATED STEEL ROUND

Armco Drainage & Metal Prod., Inc.

OXYGEN-ADMINISTERING EQUIPMENT

Mine Safety Appliances Co. — "DEMAND PNEOPHORE," "PNEOLATOR," "PNEOPHORE," "PULMONARY VENTILATOR' '

PACKING

Anchor Packing Co.
American Biltrite Rubber Co., Boston Woven Hose & Rubber Co. Div.—"BOSTON"
Flood City Brass & Electric Co.
Garlock Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Johns-Manville—"CENTRI-PAC," "CHEMPAC," "JEWETT," "KEARSARGE," "MOGUL," "NAVALONE," "SEA RINGS," "MOBILENE," "UNEPAC," "CUMPAC," "INTERLOCKED"
Industrial Rubber Products Co. (W. Va.)
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"RM"
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Div., H. K. Porter Co., Inc.

PACKING EQUIP., BAG

Bemis Bros. Bag Co.—"PACKERETTE"

PAINTS

Samuel Cabot, Inc.—"CABOT'S FLEXIBLAC,' '"CABOT'S COLLOPAKES," "HOUSE & TRIM' '
Philip Carey Mfg. Co.
Joseph Dixon Crucible Co.
Magichemical Co.—"MAGI-VULC"
E. I. du Pont de Nemours & Co., Inc.—"DUCO," "DULUX"
Pittsburgh Plate Glass Co.— "PITTSBURGH"
Rust-Oleum Corp.—"RUST-OLEUM"
Sika Chemical Corp.—"SIKA-KOTE"
The Wilbur & Williams Co., Inc. —"C.C. 40," "TUF-QUIK"

PAINTS, ALUMINUM

Joseph Dixon Crucible Co. (including aluminum heat-resistant)
E. I. du Pont de Nemours & Co., Inc. and aluminum and reflective
Magichemical Co.—"MAGI-VULC"
Master Bronze Powder Co., Inc. —"BROMA," "DERUSTO" (including colored and enamelized spray)
Pittsburgh Plate Glass Co. — "PITTSBURGH" including reflective
Rust-Oleum Corp.—"RUST-OLEUM"
The Wilbur & Williams Co., Inc. —"TOTALUME," "RE-3 COLORED ALUMINUM COATING," "DAMPCOAT"

PAINTS, ELECTRICAL INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.—"GLYPTAL "

PANELBOARDS

The Bristol Co.—"BRISTOL'S"
Crouse-Hinds Co.
The Daniels Co.
Hays Corp.
I-T-E Circuit Breaker Co.
Johns-Manville—"ASBESTOS EBONY," "OHMSTONE"
Westinghouse Electric Corp.

PANELS, ELECTRICAL CONTROL

The Post-Glover Electric Co.— "P-G"

PANELS, INSTRUMENT

The Bristol Co.—"BRISTOL'S"
Foxboro Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
Westinghouse Electric Corp.

PAPER, ELECTRICAL INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

PARTS, DRILLING MACHINES

Buffalo-Springfield Co., Div. of Koehring Co.—"KEYSTONE," "STAR"
Kensington Steel, Div. of Poor & Co.
Mobile Drilling, Inc.

PARTS, LOCOMOTIVE

Cooke-Wilson Electrical Supply Co.
Flood City Brass & Electric Co.
The Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Kelly Manufacturing Co., Machine Parts Div.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, MINING MACHINERY

American Manganese Steel Div., American Brake Shoe Co.— "AMSCO"
American Brake Shoe Co., National Bearing Div.
Cooke-Wilson Electrical Supply Co.
Flood City Brass & Electric Co.
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kelly Mfg. Co., Machine Parts Div.
Kensington Steel, Div. of Poor & Co.
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
North American Gear Co. "NAMCO"
Penn Machine Co.
Pittsburgh Gear Co.
Taylor-Wharton Co., Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, MOTOR, ELECTRICAL

Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Kelly Manufacturing Co., Machine Parts Div.
Reliance Elec. & Eng. Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, PULVERIZER, MANGANESE

Kensington Steel, Div. of Poor & Co.

PARTS, SHUTTLE CAR

Cooke-Wilson Electrical Supply Co.
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kelly Mfg. Co., Machine Parts Div.
National Mine Service Co.
Penn Machine Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, TRUCK

C. S. Card Iron Works
Hendrickson Mfg. Co.
KW-Dart Truck Co.

PARTS, WEARING, TRACTORS & EARTHMOVERS

Interstate Equipment Corp.

PENTAPRISMS, (RIGHT-ANGLE) (SINGLE & DOUBLE)

Kern Instruments, Inc.

PH INDICATORS

Analytical Measurements, Inc.
The Bristol Co.—"BRISTOL's"
Fisher Scientific Co.
Foxboro Co.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Scientific & Process Instruments Div., Beckman Instruments, Inc.

PHOTOCOPY EQUIPMENT, MATERIALS

Peerless Photo Products, Inc.— "DRI-STAT" "QUICK SILVER"

PHOTO MOSAICS

Aero Service Corp.
American Air Surveys, Inc.

PICKING TABLES

Carrier Division, Chain Belt Co.— CARRIER NATURAL FREQUENCY"
Galis Electric & Machine Co.
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
E. F. Marsh Engrg. Co. — "MARCO"
Morse Bros. Machinery Co.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Wilmot Engineering Co.

PICKS

The Bowdil Co.
Gibraltar Equipment & Mfg. Co.
The Leetonia Tool Co.

PILING, TREATED

T. J. Moss Tie Co.
Republic Creosoting Co., Div. of Reilly Tar & Chemical Corp.

PILING-PRESSURE-CREOSOTED, PENTA TREATED

T. S. Muss Tie Co.

PILLOW BLOCKS

Browning Mfg. Co.
Chain Belt Co.
Link-Belt Co., Dept. CAMGL-61— "LINK-BELT," "JPS," "SPHERICAL," "FLEX-BLOCK," "MILLBEARING"
Marlin-Rockwell Crop.—"MR"
New Departure Div., General Motors Corp.

PILLOW BLOCKS, ANTIFRICTION-BEARING

Bearings, Inc.
Chain Belt Co.—"SHAFER"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SC-SCM-SLP," "SPHER-ALIGN"
The Fafnir Bearing Co.
Hewitt-Robins Incorporated — "JONES"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61 —"LINK-BELT," "JPS," "MILLBEARING," "SPHERICAL"
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.— "SEALMASTER"
Transall, Inc.
Wilmot Engineering Co.

PILLOW BLOCKS, SLEEVE-BEARING

Bearings, Inc.
Chain Belt Co.—"REX"
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"SLEE-VOIL"
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61 "FLEXBLOCK," "MILLBEARING," "SPHERICAL" "JPS"
K. Prins & Associates
Transall, Inc.
Wilmot Engineering Co.

PINIONS

Hewitt-Robins Incorporated
Illinois Gear & Machine Co.
Link-Belt Co., Dept. CAMGL-61

PIPE, ALUMINUM

Aluminum Company of America —"UNI-STRENGTH" "DUOTRACE,' 'including irrigation
Kaiser Aluminum & Chemical Sales Co.
Revere Copper & Brass Inc.
Reynolds Metals Co., including irrigation

PIPE, ASBESTOS-CEMENT

Johns-Manville—"TRANSITE"
Keasbey & Mattison Co.
Midland Pipe & Supply Co.— "TRANSITE"

PIPE, BITUMINIZED FIBER

Triangle Conduit & Cable Co., Inc.

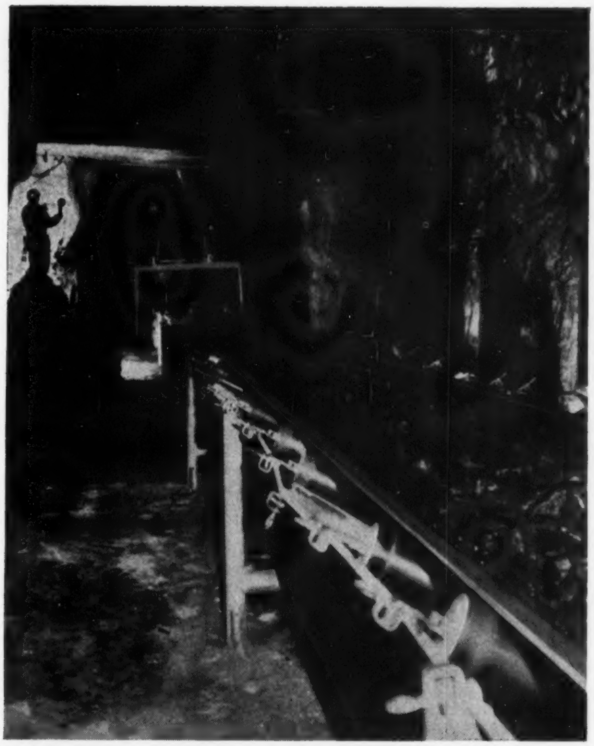
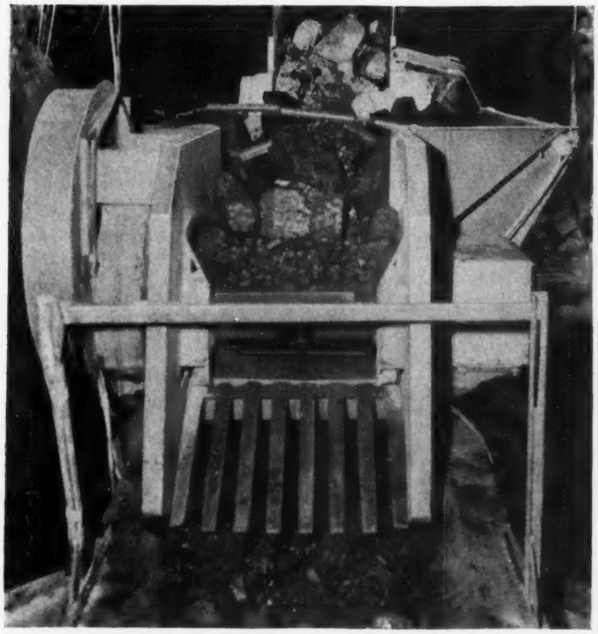


Photo shows even loading of coal on belt with Ratio-Feeder which reduces overloading, damage and spilling.



Shuttle car loads Ratio-Feeder at high rate for fast turn around. Ratio-Feeder protects belt from shuttle car damage.

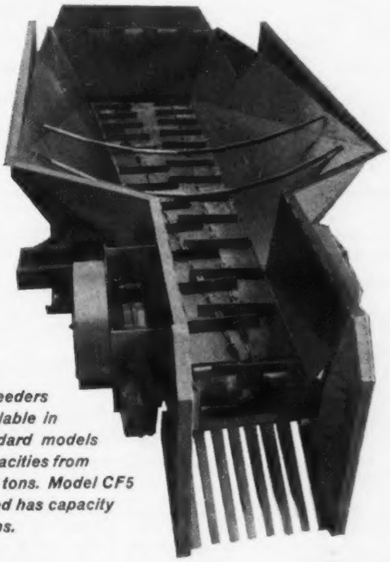
17 RATIO-FEEDERS

help control cost-per-ton at

CLINCHFIELD'S MOSS No. 3

COST-SAVING FEATURES INCLUDE

- Faster discharge of shuttle car loads and speedier return of cars.
- Ability to load 5 high tonnage sections on one mother belt without selective loading. Without Ratio-Feeder, three such sections would seriously overload mother belt at times.
- Little or no clean-up expense along belt lines.
- Reduced car and belt maintenance.
- Reduced downtime on belt.



Ratio-Feeders are available in six standard models with capacities from 2¼ to 15 tons. Model CF5 illustrated has capacity of 15 tons.

Clinchfield ordered its first Ratio-Feeder in February, 1958 while Moss No. 3 was still under construction... the most recent units were added in mid-1960. It is estimated that the first 10 Ratio-Feeders have averaged around 875,000 tons each of raw coal. Ratio-Feeders are used by many prominent mines... are proved equipment.

RATIO-FEEDER DISTRIBUTORS

Carlsbad Supply Company, Carlsbad, New Mexico
(Southern New Mexico)

Joseph Schonthal & Associates, Chicago 4, Illinois
(Illinois, Indiana, Western Kentucky)

Schroeder Brothers Corporation, McKees Rocks, Pennsylvania
(Pennsylvania, West Virginia, Virginia, Eastern Kentucky)

National Equipment Company, Salt Lake City, Utah
(Far West)

J. L. Thomas Company, Birmingham, Alabama
(Alabama)

send for bulletin

CM
MINE EQUIPMENT

COLUMBUS McKINNON CORPORATION

Mining Equipment Division

53 FREMONT AVENUE, TONAWANDA, NEW YORK

Materials Handling Equipment Specialists For 75 Years

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Phelps Dodge Copper Products Co. (copper, red brass)
Revere Copper & Brass Co. (copper, red brass)
Triangle Conduit & Cable Co. Inc. (copper, red brass)

PIPE, CAST-IRON, WROUGHT-IRON
A. M. Byers Co. (wrought)
Midland Pipe & Supply Co. (wrought)
United States Pipe & Foundry Co. (cast)
Wilmot Engineering Co. (cast, wrought)

PIPE, LINED
American Alloy Corp. (carbide-coated)
Jones & Laughlin Steel Corp. (cement)
United States Pipe & Foundry Co. (cement)

PIPE, CORROSION-RESISTANT
Duriron Co., Inc.

PIPE, CORRUGATED
Armco Drainage & Metal Prod., Inc.
Republic Steel—"REPUBLIC"

PIPE, DRIVE, AND DRIVING WINCHES
Acker Drill Co. Inc.—"MODEL RG and RGT"

PIPE, PLASTIC
Amercoat Corp.—"BOND—STRAND"
A. M. Byers Co.
Carlon Products Corp.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Irvington Div. of Minnesota Mining & Mfg. Co.
Johns-Manville Plastics Corp.—"DUR-X"
Johnson Plastic Corp.—"KRALASTIC"
Midland Pipe & Supply Co.
National Mine Service Co.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son Inc.
Triangle Conduit Cable Co., Inc.
United States Rubber Co.
Yardley Plastics Co.—"CLEAR-STREAM"
The Youngstown Sheet and Tube Co.—"FIBERCAST"

PIPE, RUBBER
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Linatex Corp. of America
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"CONDOR"
United States Rubber Co.

PIPE, RUBBER-LINED
Farris Flexible Valve Corp.—"FLEXVALVE," "SUPER SEAL"
The Galigher Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Naylor Pipe Co.
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"CONDOR"
United States Rubber Co.

PIPE, SEAMLESS
Bethlehem Steel Co.
Phoenix Steel Corp., Structural & Tube Divs.

PIPE, SPIRAL-WELDED
Armco Drainage & Metal Prod. Inc.
Midland Pipe & Supply Co.
Naylor Pipe Co.

PIPE, STAINLESS STEEL
Allegheny Ludlum Steel Corp.—"ALLEGHENY"
Cruicible Steel Co. of America — "CONTOUR TRENTWELD"
Midland Pipe & Supply Co.
National Tube Div., United States Steel Corp.—"USS"

PIPE, STEEL, STEEL-WELDED
Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crane Co.
Jones & Laughlin Steel Corp.
Koven Fabricators, Inc.
Midland Pipe & Supply Co.
National Supply Div., Armco Steel Corp. "SPANG"
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steelfi"REPUBLIC"
Joseph T. Ryerson & Son. Inc.
The Youngstown Sheet and Tube Co.—"YOLOY"

PIPE, STEEL, PLASTIC-COATED
Republic Steel — "X-TRU-COAT"

PIPE, WOOD, WOOD-STAVE
Peter O. Sutphen Co.

PIPE CLAMPS
Marman Div., Aeroquip Corp.

PIPE COUPLINGS
Dresser Mfg. Div., Dresser Industries, Inc.—"DRESSER "
McDowell Mfg. Co.— "FAST-LINE" (all services)

PIPE COUPLINGS, FLEXIBLE
Victaulic Co. of America—"VICTUALIC"

PIPE COUPLINGS, GROOVED
Dresser Mfg. Div., Dresser Industries, Inc. — "KUPL-LOK," "TM"
Eastern Sales Co., Div. of the Eastern Co.—"EASTERN"

PIPE COVERINGS
Philip Carey Mfg. Co.—"CAREYTEMP" "AIRCELL," "IMPERVO," "PERFECTO,"
The Galigher Co.
Gustin-Bacon Mfg. Co.—"SNAP-ON," "ULTRA FOAM"
Johns-Manville "TRANTEX," "TRANSHIELD," "DURA-MESH," "DURATAPE," "BLUE FLAG," "DURAMAT"
Pittsburgh Corning Corp.—"STAY-DRY," "FOAMGLAS"
The Ruberoid Co.

PIPE FABRICATION
Dravo Corp.
The Stearns-Roger Mfg. Co.

PIPE FITTINGS
Anchor Coupling Co., Inc.
Armco Drainage & Metal Prod., Inc.
Dresser Mfg. Div., Dresser Industries, Inc.
Eastern Sales Co., Div. of The Eastern Co.—"EASTERN CORVEL 51"
The Fairbanks Co.—"DART"
Grinnell Co.
Gustin-Bacon Mfg. Co.
McDowell Mfg. Co.—"FAST-LINE" (portable tubing)
Midland Pipe & Supply Co.
Naylor Pipe Co.
United States Pipe & Foundry Co.
Victaulic Co. of America—"VICTAULIC"
Walworth Co.
The Weatherhead Co.

PIPE FITTINGS, BRASS, BRONZE
Grinnell Co. (brass)
Ampco Metal, Inc. (bronze)
Walworth Co. (bronze)

PIPE FITTINGS, CAST IRON
United States Pipe & Foundry Co.

PIPE FITTINGS, CAST & MALLEABLE IRON
Grinnell Co.

PIPE FITTINGS, FLANGES—PLASTIC & WELDED
Midland Pipe & Supply Co.
United States Rubber Co.
Walworth Co.

PIPE FITTINGS, FLANGES—WELDING
Tube Turns Div. of Chemetron Corp.

PIPE FITTINGS, FORGED STEEL
Bethlehem Steel Co.
Ladish Co.

PIPE FITTINGS, PLASTIC
Amercoat Corp.—"Quick-Lock"
Carlon Products Corp.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Grinnell Co.
Johns-Manville Plastics Corp.—"DUR-X"
Johnson Plastic Corp.
Midland Pipe & Supply Co.
National Mine Service Co.
Republic Steel—"REPUBLIC"
Triangle Conduit & Cable Co.
United States Rubber Co.
Walworth Co.
Yardley Plastics Co.
The Youngstown Sheet and Tube Co.

PIPE FITTINGS, RUBBER
United States Rubber Co.

PIPE FITTINGS, STAINLESS-STEEL
ESCO Corp.
Victaulic Co. of America
Ladish Co.

PIPE FITTINGS, WELDING
Grinnell Co.

PIPE FITTINGS, WROUGHT-IRON
A. M. Byers Co.

PIPE FLANGES, FORGED, STAINLESS, ALLOYS
Bethlehem Steel Co.
Ladish Co.

PIPE GROOVERS
Gustin-Bacon Mfg. Co.—"ROLL-A-GROOVE," "BEAVER"
Victaulic Co. of America—"VIC-GROOVER," "VI-EASY"

PIPE HANGERS
Grinnell Co.

PIPE, PORTABLE
McDowell Mfg. Co.—"JAL-ZINC" tubing, all services

PIPE-REPAIR, CLAMPS, SLEEVES
Dresser Mfg. Div., Dresser Industries, Inc.—"HANDI-BAND®"

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Toledo Pipe Threading Machine Co.

PIPEWALL-THICKNESS GAGES
Industrial Nucleonics Corp.—"ACCURAY"

PIPING SYSTEMS FABRICATION WELDING
The Galligher Co.
Grinnell Co.
Midland Pipe & Supply Co.

PISTON RINGS
Koppers Co., Inc. Metal Products Div.—"AMERICAN HAMMERED INDUSTRIAL"

PLANERS, COAL
Mining Progress, Inc.

PLASTIC SHEETS, PLATE, PIPE
Joseph T. Ryerson & Son, Inc.

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Bethlehem Steel Co.
Crucible Steel Co. of America
Jones & Laughlin Steel Corp.—"JALLOY"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Revere Copper & Brass Inc.
United States Steel Corp.—"USS CARILLOY," "USST-1," "USS FC"
The Youngstown Sheet and Tube Co.

PLATE, FLOOR
Jones & Laughlin Steel Corp.—"JAL-THREAD," "JUNIOR JAL-THREAD"
Kanawha Mfg. Co.

PLATE, STEEL
Allegheny Ludlum Steel Corp.—"ALLEGHENY" stainless
Bethlehem Steel Co.
Crucible Steel Co. of America
The Daniels Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Phoenix Steel Corp., Structural & Tube Divs.
W. J. Savage Co.
Stulz-Sickles Co.—"MAN-GANAL"
United States Steel Corp.
The Youngstown Sheet and Tube Co.

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Aluminum Company of America
Kanawha Mfg. Co.
Reynolds Metals Co.

PLATE & SHEET, ZINC
Illinois Zinc Co., A Div. of Hydrometals

PLIERS, ELECTRICIANS
Snap-On Tools Corp.

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Albert & J. M. Anderson Mfg. Co.

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Crouse-Hinds Co.
Joy Mfg. Co.
Ohio Brass Co.
United States Rubber Co.

POLE-LINE MATERIALS
Duquesne Mine Supply Co.
I-T-E Circuit Breaker Co.
Mosebach Electric & Supply Co.

POLES, TREATED
Koppers Co., Inc., Wood Preserving Div.
T. J. Moss Tie Co. (and Penta)
Republic Creosoting Co., Div. of Reilly Tar & Chemical Corp.

POLES, TROLLEY
Duquesne Mine Supply Co.

POLISHERS, FINE SOLIDS-REMOVAL FROM WATER
Bird Machine Co.—"BIRD"

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Denver Equipment Co.—"DENVER"
Dorr-Oliver-Incorporated
Heyl & Patterson, Inc.
Industrial Phsics & Electronics Co.
Link-Belt Co., Dept. CAMGL-61

POLLUTION-CONTROL SYSTEMS, AIR
American Air Filter Co., Inc.

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The Wood Shovel & Tool Co.

POSTERS, MINE SAFETY
Elliott Service Co., Inc.

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American Steel & Wire, U. S. Steel Corp.—"AMERICAN"
Bethlehem Steel Co.

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T. J. Moss Tie Co.

POTHEADS
G & W Electric Specialty Co.

POWDER BAGS—See Bags, Explosive

POWDER STORAGE, FIELD UNITS
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Dravo Corp.
E. I. du Pont de Nemours & Co., Inc.
Hercules Powder Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

POWDERED METAL PARTS
Keystone Carbon Co.

POWER DIVIDERS
Tulsa Products Div. Vickers, Inc.—"TULSA"

POWER-FACTOR METERS, RECORDERS
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
Westinghouse Electric Corp.

POWER STEERING GEARS, HYDRAULIC
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POWER TOOLS, ELECTRIC
Disston Div., H. K. Porter Co., Inc.

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Southwestern Engineering Co.
G. C. Thomas Mfg. Co.
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Thomas Engineering & Construction Co.
WEMCO Div., Western Machinery Co.—"WEMCO MOBIL-MILL"

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Blackhawk Industrial Div.
Denison Eng'g Div. American Brake Shoe Co.
ESCO Corp.
Owatonna Tool Co.

PRESSES, HYDRAULIC TRACK AND TRACK PIN, TRUCK EQUALIZING BEAM
Owatonna Tool Co.

PRIMERS
E. I. du Pont de Nemours & Co., Inc.—(HDP)

PRIMER INITIATORS—See Boosters, Ammonium Nitrate

PROPS—See Roof Support

PULLERS, FUSE
Economy Fuse Div., Federal Pacific Electric Co.
Holub Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"TRICO"

PULLERS, GEAR & WHEEL
Armstrong-Bray & Co.—"STEEL-GRIP"
Bearings, Inc.
Hewitt-Robins Incorporated
Martindale Electric Co.
Owatonna Tool Co.
Snap-on Tools Corp.—"SNAP-ON"
Templeton, Kenly & Co.—"SIMPLEX"

PULLERS, GEAR & WHEEL, HYDRAULIC
Armstrong-Bray & Co.—"HY-DRAGRIP"
Bearings, Inc.
Blackhawk Industrial Div.
Owatonna Tool Co.
Templeton, Kenly & Co.—"RE-MO-TROL"

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Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McLanahan Corp.
Spout, Waldron & Co., Inc.—"BELTSAVER"
Transall, Inc.
Webster Mfg., Inc.
T. B. Woods Sons Co.

PULLEYS, CONVEYOR—See Conveyor Belt Idlers, Conveyor-Belt Idler Pulleys

PULLEYS, DUCTILE IRON
T. B. Woods Sons Co.

PULLEYS, MOTOR
Reeves Pulley Co., Div. The Reliance Electric &Engrg.Co. —"VARI-SPEED"

PULLEYS, PAPER
Browning Mfg. Co.

PULLEYS, RUBBER-COVERED
General Splice Corp.—"MINET" "COLDBOND"
United States Rubber Co.

PULLEYS, SEMI-STEEL

Continental Conveyor & Equipment Co.
Hewitt-Robins Incorporated
McLanahan Corp.
Webster Mfg. Inc.
T. B. Woods Sons Co.

PULLEYS, STEEL

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Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Dodge Mfg. Corp.—"TAPER-LOCK"
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61 —"DIE-CROWN"
E. F. Marsh Engrg. Co.—"MARCO"
W. S. Savage Co.
Transall, Inc.

PULLEYS, WOOD

J. D. Christian Engineers

PULVERIZER PARTS, MANGANESE STEEL

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

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American Pulverizer Co.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc.
Hardinge Co., Inc.
Jeffrey Mfg. Co.

PULVERIZERS, FURNACE-FEED

Combustion Engineering, Inc.—"C-E-RAYMOND"
Gruendler Crusher & Pulverizer Co.
Kennedy-Van Saun Mfg. & Engrg Corp.
Majac Inc., Sub. of Blackstone Corp.
Williams Patent Crusher & Pulv. Co.

PULVERIZERS, LABORATORY

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Combustion Engineering, Inc.—"C-E-RAYMOND"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Holmes Bros., Inc.
Jeffrey Mfg. Co.
Mine and Smelter Supply Co.—"MASSCO MCCOOL"
Sturtevant Mill Co.
Williams Patent Crusher & Pulv. Co.

PUMPING STATIONS

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PUMP CONTROLS

Flygt Corp.

PUMP-PRIMING EQUIPMENT

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Flood City Brass & Electric Co.
Goyne Pump Co.
Nash Engineering Co.

PUMPS, AIR-DRIVEN

Chicago Pneumatic Tool Co.

PUMPS, AIR-HYDRAULIC

Ledeen Mfg. Co.

PUMPS, CENTRIFUGAL

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Allis-Chalmers Mfg. Co.
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Ampco Metal, Inc.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.—"BUFFALO"
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.—"REX"
Chicago Pneumatic Tool Co.
Dean Brothers Pumps Inc.
DeLaval Steam Turbine Co.
The Deming Co.
Dorr-Oliver, Incorporated
The Duriron Co., Inc.
Ensign Electric & Mfg. Co.
Fairbanks Morse & Co.
Flood City Brass & Electric Co.
Flygt Corp.—"FLYGT"
Gardner-Denver Company
The Gorman-Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
Homelite a div. of Textron, Inc.—**"HOMELITE"**
Ingersoll-Rand Co.
Johnston Pump Co.
LaBour Co., Inc.
Marlow Pumps, Div. of Bell & Gossett Co.
McNally-Pittsburg Mfg. Corp.
Morris Machine Works
Nagle Pumps, Inc.
National Mine Service Co.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Pennsylvania Pump & Compressor Co.—"THRUSTFRE"
Rice Pump & Machine Co.—"RICE"
Roots-Connersville Blower, Div. Dresser Industries, Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, CENTRIFUGAL, REBUILT

Leman Machine Co.

PUMPS, CORROSION-RESISTANT

The Duriron Co., Inc.
Flygt Corp.
Johnston Pump Co.
A. R. Wilfley & Sons

PUMPS, DEEP-WELL

The Deming Co.
Layne & Bowler Pump Co.—"VERTI-LINE"
Layne & Bowler, Inc.—"LAYNE"

PUMPS, DIAPHRAGM

Barnes Mfg. Co.
B-I-F Industries, Inc.—"CHEM-O-FEEDER," "ADJUSTO-O-FEEDER," "PROPOR-EER"
Carver Pump Co.
Chain Belt Co.—"REX"
Denver Equipment Co.—"DENVER ADJUSTABLE STROKE"
Dorr-Oliver, Incorporated
The Eimco Corp.
Gardner-Denver Company
The Gorman-Rupp Co.
Homelite a div. of Textron, Inc.—"HOMELITE"
Marlow Pumps, Div. of Bell & Gossett Co
Morse Bros. Machinery Co.
Ore Reclamation Co.
Rice Pump & Machine Co.—"RICE"

PUMPS, DRUM

Aro Equipment Corp.
General Scientific Equipment Co.—"GS"
Gray Co., Inc.—"DIRECT-FROM-DRUM"
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co.—

PUMPS, FIRE

Allis-Chalmers Mfg. Co.
Flood City Brass & Electric Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Layne & Bowler Pump Co.—"VERTI-LINE"
Porto Pump, Inc.
Rice Pump & Machine Co.—"RICE"

PUMPS, FROTH-HANDLING

Denver Equipment Co.—"DENVER"
A. R. Wilfley & Sons

PUMPS, HIGH-PRESSURE

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

PUMPS, JETTING

Barnes Mfg. Co.
The Deming Co.
Fairbanks Morse & Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Porto Pumps, Inc.

PUMPS, METERING

B-I-F Industries, Inc.
Roots-Connersville Blower, Div. Dresser Industries Inc.

PUMPS, OIL

Canton Stoker Corp.—"WAGENER"

PUMPS, PISTON & PLUNGER

Canton Stoker Corp.—"WAGENER"
Dean Brothers Pumps Inc.
The Deming Co.
Flood City Brass & Electric Co.
Gardner-Denver Company
Goulds Pumps, Inc.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Co.
Ledeen Mfg. Co.
National Mine Service Co.
National Supply—Div., Armco Steel Corp. "NATIONAL"
Worthington Corp.

PUMPS, PLUNGER

Aldrich Pump Co.

PUMPS, PORTABLE SLUDGE, AIR

Chicago Pneumatic Tool Co.
Herold Mfg. Co.

PUMPS, PRESSURE-TESTING

Porto Pump Inc.

PUMPS, PRIMING

Kenco Pump Div., American Crucible Products Co.

PUMPS, RADIAL PISTON

AE Industrial Div., Aircraft Armaments, Inc.—"HELE-SHAW," "HYRAMITE"

PUMPS, ROTARY

The Deming Co.

PUMPS, ROTARY-PISTON GEAR

Kinney Vacuum Div., The New York Air Brake Co.

PUMPS, SAND, ABRASIVE HANDLING

Allis-Chalmers Mfg. Co.
Denver Equipment Co.—"DENVER S-R-L"
Johnston Pump Co.
A. R. Wilfley & Sons

PUMPS, SLURRY, SOLIDS-HANDLING

The Allen-Sherman-Hoff Pump Co.—"HYDROSEAL-CEN-TRISEAL"
Allis-Chalmers Mfg. Co.
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Canton Stoker Corp—"WAGENER"
Carver Pump Co.
Dorr-Oliver Incorporated
The Galigher Co.—"VACSEAL"
Goulds Pumps, Inc.
Goyne Pump Co. (horizontal and vertical)
Linatex Corp. of America
Marlow Pumps, Div. of Bell & Gossett Co.
Meckum Engineering, Inc.
Morris Machine Works
Nagle Pumps, Inc.
Ore Reclamation Co.
Robbins & Myers, Inc.—"MOYNO"
WEMCO Div., Western Machinery Co.—"WEMCO TORQUE FLOW"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, SPRAY HIGH-PRESSURE

Flood City Brass & Electric Co.

PUMPS, SUBMERSIBLE

Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Chicago Pneumatic Tool Co.
The Deming Co.
Flygt Corp.—"FLYGT"
The Gorman-Rupp Co.
Johnston Pump Co.
Kenco Pump Div. of The American Crucible Products Co (3 phase)
Layne & Bowler Pump Co.
Layne & Bowler, Inc.—"LAYNE"

PUMPS, SUMP

The Allen-Sherman-Hoff Pump Co.—"HYDROSEAL"
Allis-Chalmers Mfg. Co.
Aurora Pump Div., The New York Air Brake Co.
Barnes Mfg. Co.
Barrett Haentjens & Co.
Buffalo Forge Co.—"BUFFALO"
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chicago Pneumatic Tool Co.
The Deming Co.
Fairbanks Morse & Co.
Flood City Brass & Electric Co.
Flygt Corp.—"FLYGT"
The Galigher Co.—"GALIGHER"
Gardner-Denver Company
The Gorman-Rupp Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Johnston Pump Co.
Kenco Pump Div. of The American Crucible Products Co.
Layne & Bowler, Inc.—"LAYNE"
Layne & Bowler Pump Co.—"VERTI-LINE"
Le Roi Div., Westinghouse Air Brake Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Morris Machine Works
Nagle Pumps, Inc.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Robbins & Myers, Inc.—"MOYNO"
Schramm, Inc.
Thor Power Tool Co.
Worthington Corp.

PUMPS, TRANSFER

Aro Equipment Corp.
Lincoln Engineering Co., Div. of McNeil Mach. & Engrg. Co.
A. R. Wilfley & Sons

PUMPS, TRASH & SLUDGE

Flygt Corp.—"FLYGT"

PUMPS, TURBINE

Aurora Pump Div., The New York Air Brake Co.

PUMPS, VACUUM

Allis-Chalmers Mfg. Co.
Canton Stoker Corp.—"WAGENER"
Chicago Pneumatic Tool Co.
Joy Mfg. Co.
Kinney Vacuum Div., The New York Air Brake Co.
Nash Engineering Co.

PUMPS, VERTICAL CENTRIFUGAL

Allis-Chalmers Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.—"BUFFALO"
Dean Brothers Pumps Inc.
The Gorman-Rupp Co.
Gould Pumps, Inc.
Morris Machine Works
Nagle Pumps, Inc.

PUMPS, VERTICAL, CENTRIFUGAL AND TURBINE

Allis-Chalmers Mfg. Co.
Aurora Pump Div., The New York Air Brake Co.
Byron Jackson Pumps, Inc. A Sub. of Borg-Warner Corp.
Carver Pump Co.
The Deming Co.
Ensign Electric & Mfg. Co.
Fairbanks Morse & Co.
Gould Pumps, Inc.
Ingersoll-Rand Co.
Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp.
Pennsylvania Drilling Co.
Roots-Connersville Blower Div., Dresser Industries, Inc.
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, VERTICAL, TURBINE

Johnston Pump Co.
Layne & Bowler, Inc.—"LAYNE"

PUSHBUTTONS

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Cutler-Hammer, Inc.—"ROTO-PUSH"
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

PYROMETERS

The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.


more money for your money belt..
with
"CANTON"
MINING EQUIPMENT
Remember you can install a "Canton" now and pay us out of savings.
Write for complete brochures. Please use street and zone numbers.
Canton Automatic Mine Doors
The Automatic Door operates mechanically by weight of car on activating levers. Air power operation may be had where desirable. Operates at any trip speed. Two doors provide air lock.
Air Power Car Transfer
One man does the work of three and faster. Entire train loaded out on a single track. Expedites servicing cars to mucking machine.
Track Switch Thrower
Either electric or air operated. Route selections made by motorman at full trip speeds. Eliminates accident potential and extra man. Also ideal as Derailer. Manual or automatic contactors available.
Canton Track Cleaner
Clean entire track area mechanically in one pass—no costly hand labor, no dozers or loaders required—hydraulic controls throughout. "Pays for itself in one sweep through mine." Now used in coal, iron, copper, lead, potash, and salt mines.
Mighty Midget Duster
Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines—inexpensive—capacity 7 tons dust per shift.
Manually Operated Car Transfer
No alterations to track—quickly installed and relocated—less rib to shoot than for jump switch—no hazards of cherry picker, anti-friction bearings for easy hand operation.
Little Chief for Wet Or Dry Dusting
Rubber tire model 22½" high—skid model 18½" for shuttle buggies, belts or mine cars; hydraulic self-propelled model available. 34 to 60 lbs. dust per minute through 50 to 250 ft. of 2" hose.
Dustmaster
The track mounted Hi-pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 feet from haulway.
Canton Cable Splicers
Reduce down-time in splicing cable. Machine man should carry a pocketful. Just pound around cable and keep on working. No special tools required.
A·M·D·CO
The American Mine Door Company
2057 DUEBER AVENUE, S.W. • CANTON 6, OHIO

Minneapolis-Honeywell Regulator Co., Brown Instruments Div.—"ELECTRONIK 15," "ELECTRONIK 17"
West Instrument Corp.—"GARDSMAN-VERI-TELL"

RADIO SYSTEMS

General Electric Co., Communication Products Dept.
Mine Safety Appliances Co.—"MINE PHONE"
Motorola Communications & Electronics, Inc.—"MOTRAC (Two-way radio)," "T-POWER (Two-way radio)"

RAIL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"CF&I," "HI-SI"
Gibraltar Equipment & Mfg. Co.
Inland Steel Co.
Morse Bros. Machinery Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"
United States Steel Corp

RAIL BENDERS

The Aldon Co.
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE" "RATCHET TYPE"
National Mine Service Co.
Utility Mine Equipment Co.—"UMECO"
Watt Car & Wheel Co.

RAIL BOLTS

Bethlehem Steel Co.
The Colorado Fuel & Iron Corp.—"C F & I"
Gibraltar Equipment & Mfg. Co.
Morse Bros Machinery Co.
Republic Steel Corp.
Screw and Bolt Corp. of America

RAIL-BOND TERMINALS

American Mine Door Co.

RAIL BONDS

American Steel & Wire Div., U. S. Steel Corp. "TIGER-BRAZE" "TIGER-WELD"
Cable Vulcanizing Shop, Inc.
Copperweld Steel Co.—"COPPERWELD"
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CADWELD"
Fadlevich Cable Vulcanizing Shop, Inc.
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Penn Machine Co.—"EVERLAST SUPER-WELD"

RAIL BRACES

Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAIL CLAMPS

Dravo Corp.
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co.
Mosebach Electric & Supply Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAIL CONTACT DEVICES

General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

RAIL CROSSINGS, RUBBER

Goodyear Tire & Rubber Co.

RAIL DOLLIES

Templeton, Kenly & Co.—"SIMPLEX"

RAIL DRILLS

Gibraltar Equipment & Mfg. Co.—"RICHTAL HEAVY DUTY"

RAIL FROGS

Bethlehem Steel Co.
C. S. Card Iron Works
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAIL LEVELERS, SPOT BOARDS

Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLU"

RAIL PUNCHES

Gibraltar Equipment & Mfg. Co. —"GEMCO TRU-BLUE"
Mine Safety Appliances Co.—"VELOCITY-POWER"
National Mine Service Co.
Utility Mine Equipment Co.—"UMECO"

RAILROADS, RAILWAYS

Baltimore & Ohio R. R.
New York Central System

RAIL SIGNAL SYSTEMS, MANUAL & AUTOMATIC

American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

RAIL SPIKE DRIVERS

American Brake Shoe Co., Railroad Products Div.

RAIL SPIKES

Bethlehem Steel Co.
The Colorado Fuel & Iron Corp., "C F & I"
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
Republic Steel Corp.
The Youngstown Sheet and Tube Co.

RAIL SPIKES, RAILROAD

Jones & Laughlin Steel Corp.

RAIL SPLICE BARS, PLATES

Bethlehem Steel Co.
The Colorado Fuel & Iron Corp. —"C F & I"
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"
Morse Bros. Machinery Co.

RAIL SPRING-SWITCH SNUBBERS

Cheatham Elec. Switching Device Co.
General Equipment & Manufacturing Co.

RAIL SWITCH-POSITION INDICATORS

American Mine Door Co.
Cheatham Elec. Switching Device Co.
General Equipment & Manufacturing Co.
Joy Mfg. Co.
Miners Hardware Supply Co.

RAIL SWITCHTHROWERS

General Equipment & Manufacturing Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.

RAIL SWITCHTHROWERS, AIR, AUTOMATIC

American Mine Door Co.—"AERO-THROW"

RAIL SWITCHTHROWERS, ELECTRIC, AUTOMATIC

American Mine Door Co.—"ELECTRI-THROW"
Cheatham Elec. Switching Device Co.—"CHEATHAM SWITCH"
General Equipment & Manufacturing Co.
Joy Mfg. Co.

RAIL TIE PLATES

Bethlehem Steel Co.
Morse Bros. Machinery Co.
United States Steel Corp.

RAIL-TIE SPACER BARS

A. M. Byers Co.

RAIL & TIE TONGS

Gibralter Equipment & Mfg. Co.

RAIL TIES, TREATED

Koppers Co., Inc., Wood Preserving Div. (creosoted)—"WOLMANIZED"
T. J. Moss Tie Co.
Republic Creosoting Co., Div. of Reilly Tar & Chemical Co.

RAIL TIES, STEEL

Bethlehem Steel Co.
National Mine Service Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAIL TRACKWORK

American Brake Shoe Co., Railroad Products Div.

RAIL TURNOUTS, SWITCHES, STANDS

American Brake Shoe Co., Railroad Products Div.
Bethlehem Steel Co.
C. S. Card Iron Works
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAIL WELDING MATERIALS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Thermex Metallurgical, Inc.

RAILS, GUARD

Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

RAILS, TRANSITION

C. S. Card Iron Works
Miners Hardware Supply Co.

RAMS, HYDRAULIC

Owatonna Tool Co.

RAMMING MIXES

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"FURN-A-RAM," "RAM-CAST," "HI RAM," "PERMANENTE 165," "PERMANENTE 84"

READOUT INSTRUMENTS, DATA DISPLAY AND TRANSFER

Union Switch & Signal, Div. of Westinghouse Air Brake Co. "READALL"

REAGENT CHEMICALS

Fisher Scientific Co.

REAGENTS

American Cyanamid Co., Explosives and Mining Chemical Dept.—"AEROFLOC®"

REAMERS, SPIRAL EXPANSION

Martindale Electric Co.

RECONDITIONING, BIRD CONVEYORS

American Alloy Corp.

RECORDERS, OPERATING-HOUR

The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.

RECORDERS, TEMPERATURE

West Instrument Corp.—"MARKSMAN"

RECTIFIERS, COPPER-OXIDE

Union Switch & Signal, Div. of Westinghouse Air Brake Co.

RECTIFIERS, GERMANIUM

Allis-Chalmers Mfg. Co.

RECTIFIERS, MERCURY-ARC

Allis-Chalmers Mfg. Co.—"EXCITRON"
General Electric Co., Apparatus Sales Div.
Herbert S. Littlewood
Westinghouse Electric Corp.

RECTIFIERS, SELENIUM

Allis-Chalmers Mfg. Co.
General Electric Co., Apparatus Sales Div.
Perkin Electronics Corp.
Syntron Co.
Westinghouse Electric Corp.

RECTIFIERS, SILICON

Allis-Chalmers Mfg. Co.
I-T-E Circuit Breaker Co.
Perkin Electronics Corp.
Syntron Co.
Westinghouse Electric Corp.

REDUCTION GEARS, INDUSTRIAL, ENGINE INSTALLATION

The Snow-Nabstedt Gear Corp.

REELS, LUBRICATING HOSE

Aro Equipment Corp.
Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co. "LUB-REELS"

REFRACTORIES

Bigelow-Liptak Corp.
Philip Carey Mfg. Co.
Corhart Refractories Co., Sub. of Corning Glass Works
Joseph Dixon Crucible Co.
Johns-Manville—"FIRE-CRETE," "BLAZE-CRETE," "HELLITE," "FIREITE"
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.
Norton Co.—"ALUNDUM," "CRYSTOLON," "MAGNORIT," "ZIRCONIUM OXIDE"
H. K. Porter Co., Refractories Dept.

REFRACTORIES, ABRASION-RESISTANT

Corhart Refractories Co., Sub. of Corning Glass Works—"CORHART ZAC"

REFRACTORIES, CASTIBLE

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"FURNASCRETE," "HI-STRENGTH F-334S," "I-R-C," "I-R-C 20," "MEXICAST," "MILL-CRETE," "PUROCAST 3000," "PUROTAB," "SAKONITE," "LOERODE," "ACITAB"
H. K. Porter Co., Refractories Dept.

REFRACTORIES, CHROME

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"CHROME CONCRETE," "HILO-CHROME," "SUPER CHROME CONCRETE," "KAISER CHROME BURNED BRICK," "KAISER CHROME D-C BURNED BRICK," "KAISER 91 MORTAR," "KAISER 96 MORTAR"

REFRACTORIES, GRAPHITE

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"HELSPOT," "HELSKOTE," "STULKOTE"

REFRACTORIES, PLASTIC

Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp.—"MAX BOND," "MONO-FABRIK," "SUPER MONO-FABRIC T-9"

REFRACTORY CONTRACTORS

Bigelow-Liptak Corp.

REGULATORS, DRAFT

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division

REGULATORS, ELECTRIC CONTROL

Cutler-Hammer, Inc.

REGULATORS, PRESSURE

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
Hauck Mfg. Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
Rockwell Mfg. Co.

REGULATORS, TEMPERATURE

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.—"GARDSMAN"

REGULATORS, VOLTAGE

Allis-Chalmers Mfg. Co.
Clark Controller Co.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Perkin Electronics Corp.
Westinghouse Electric Corp.

REGULATORS, WATER LEVEL

Flygt Corp.—"FLYGT"

REINFORCING BARS—See Concrete Reinforcing Bars

RELAYS, ELECTRIC

Allis-Chalmers Mfg. Co.
Cheatham Elec. Switching Device Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.

General Equipment & Manufacturing Co.
Joy Mfg. Co.
Nachod & U. S. Signal Co.
Westinghouse Electric Corp.

RELAYS, HERMETICALLY SEALED

Union Switch & Signal Div. Westinghouse Air Brake Co.

RELAYS, MERCURY

Durakool, Inc.
Joy Mfg. Co.
Mining Machine Parts Inc.

RELAYS, MINIATURE

Union Switch & Signal Div. Westinghouse Air Brake Co.

RELAYS, PHOTOELECTRIC

Clark Controller Co.

RELAYS, PNEUMATIC TIME DELAY

Elastic Stop Nut Corp. of America —"AGASTAT"

REMOTE CONTROL SYSTEMS

Fuller Transmission Div., Eaton Mfg. Co.

REPAIR SERVICE, MINE EQUIPMENT

Flood City Brass & Electric Co.
Galis Electric & Machine Co.
Maintenance Engineering Corp.
National Electric Coil Div. of McGraw-Edison Co.
W. J. Savage Co.
Simplicity Engineering Co.

REPRODUCTION EQUIPMENT

Charles Bruning Co., Inc.

RERAILERS

The Aldon Co.
American Mine Door Co.
Duquesne Mine Supply Co.
Gibralter Equipment & Mfg. Co.—"GEMCO TRU-BLUE"
Miners Hardware Supply Co.
The Nolan Co.
Sanford-Day Corp.

RESINS, IMPREGNATING

Minnesota Mining & Mfg. Co.—"SCOTCHCAST" Brand

RESISTORS

Clark Controller Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Keystone Carbon Co.—"NTC"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Carbon Co.—"OHIOHM"
Penn Machine Co.
The Post Glovers Electric Co.—"P-G STEEL GRID"
Stackpole Carbon Co.
Westinghouse Electric Corp.

RESISTORS, HEADLIGHT

Acme Machinery Co.

RESPIRATORS

American Optical Co., Safety Products Div.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co. —"GS"
Martindale Electric Co.
Mine Safety Appliances Co.—"COMFO," "DUSTFOE," "GASFOE"
Pulmosan Safety Equip. Co.
United States Rubber Co.

RETAINERS, BEARING

Bearings, Inc.
Link-Belt Co., Dept. CAMGL-61

RHEOSTATS

American Cyanamid Co., Explosives & Mining Chemicals Dept.
Central Scientific Co.
Clark Controller Co.
Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
Hercules Powder Co.
National Powder Co.
Trojan Powder Co.
Westinghouse Electric Corp.

RINGS, COLLECTOR, ARMATURE

Superior Carbon Products, Inc.
West Virginia Armature Co.

RIPPER HEADS, CONTINUOUS MINERS

The Bowdil Co.

RIPPERS, BULLDOZER, FRONT-MOUNTED

H & L Tooth Co.

RIPPERS, TRACTOR-MOUNTED

Caterpillar Tractor Co.

RIVER-LOADING PLANTS

Galis Electric & Machine Co.
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

RIVETS

Bethlehem Steel Co.
Republic Steel—"REPUBLIC"

RIVETS, BIFURCATED, SELF-CLINCHING

Crescent Fastener Co.—"CRESCENT"

ROCK-DUST DISTRIBUTORS, DRY

American Mine Door Co.—"DUSTMASTER, MIGHTY MIDGET," "LITTLE CHIEF"
Imperial-Cantrell Mfg. Co.—"JET"
Mine Safety Appliances Co.—"BANTAM," "BANTAM 400," "TYPE S," "AIRSLIDE"

ROCK-DUST DISTRIBUTORS, WET

American Mine Door Co.—"LITTLE CHIEF"
Central Mine Supply Co. Div. Pickard Industries Inc.—"NO DUST"
Mine Safety Appliances Co.—"BANTAM 400 SLURRY TYPE"

RODS, LEVELING AND STADIA

Kern Instruments, Inc.

ROLLERS, CAST-IRON

Farrell-Cheek Steel Co.
Link-Belt Co., Dept. CAMGL-61
Webster Mfg., Inc.

ROLLERS, CAST-STEEL

Farrel-Cheek Steel Co.

ROLLERS, ROAD

Austin-Western, Construction Equipment Div., Baldwin-Lima Hamilton Corp.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"

ROLLERS, SLOPE, CAST IRON, STEEL, RUBBER

C. S. Card Iron Works
Farrell-Cheek Steel Co.
Holmes Bros., Inc.
Kanawha Mfg. Co.
Sanford-Day Corp.
Vulcan Iron Works Co. (Denver) (rubber)

ROLLERS, SLOPE, WOOD

C. S. Card Iron Works
J. V. Hammond Co.

ROOF ARCHES, STEEL

Mining Progress, Inc.

ROOF BARS, ALUMINUM HINGED

Herold Mfg. Co.

ROOF BARS, STEEL

Mining Progress, Inc.

ROOF-BOLT ANCHORS

American Mine Supply Co.
Bethlehem Steel Co.

ROOF-BOLT EXPANSION SHELLS

Bethlehem Steel Co.
National Mine Service Co.
Thompson Products Valve Div., Thompson Ramo Wooldridge Inc.—"TOP-TITE"

ROOF-BOLT HOLE GASES

Ohio Brass Co.

ROOF-BOLT MATS

Commercial Shearing & Stamping

ROOF-BOLT PLATES

Republic Steel Corp.

ROOF-BOLT TENSION INDICATORS

American Mine Supply Co.
Herold Mfg. Co.
Snap-on Tools Corp.—"SNAP-ON"

ROOF-BOLTERS—SEE Drills, Roof Bolting

ROOF BOLTS, EXPANSION-SHELL

American Bridge Div., U.S. Steel
Bethlehem Steel Co.
The Colorado Fuel & Iron Corp. —"C F & I"
National Mine Service Co.
Pattin Manufacturing Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"
Republic Steel—"REPUBLIC"
Thompson Products Valve Div., Thompson Ramo Wooldridge Inc.—"TOP-TITE"
The Youngstown Sheet and Tube Co.

ROOF BOLTS, MORTAR-EMBEDMENT

Sika Chemical Corp.—"PERFO SYSTEM"

ROOF BOLTS, SQUARE-HEAD

Bethlehem Steel Co.
Sheffield Div., Armco Steel Corp.

ROOF BOLTS, SUSPENSION-ARM

H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

ROOF BOLTS, VTI TYPE

The Youngstown Sheet and Tube Co.

ROOF BOLTS, WEDGE-TYPE

American Bridge Div., U.S. Steel Corp.
Bethlehem Steel Co.
The Colorado Fuel & Iron Corp. —"C F & I"
National Mine Service Co.
Pattin Manufacturing Co.
Republic Steel—"REPUBLIC"

ROOF COATINGS

Master Bronze Powder Co., Inc. —"BROMA TOPS"

ROOF RESURFACERS

Stonhard Co.—"STONSHIELD"

ROOF SUPPORTS, HYDRAULIC

Dowty Mining Equipment Ltd.,—"DUKE," "STANDARD," "HYDROPOST"
Mining Progress, Inc.

ROOF SUPPORTS, SELF-ADVANCING

Dowty Mining Equipment Ltd.
Mining Progress, Inc.

ROOF SUPPORTS, YIELDABLE ARCH

Bethlehem Steel Co.
Commercial Shearing & Stamping Co.
Herold Mfg. Co.
Mining Progress, Inc.

ROOF SUPPORTS, YIELDING MINE PROPS

Dowty Mining Equipment Ltd.,—"DUKE," "STANDARD," "HYDROPOST"
Herold Mfg. Co.
Mining Progress, Inc.

ROOF VENTILATORS

ILG Electric Ventilating Co.—"ILG"

ROOF VENTILATORS, POWER

American-Standard Industrial Div.

ROOFING, FLASHING, COPPER

Revere Copper & Brass Inc.

ROOFING, FLASHING, NICKEL ALLOY

Huntington Alloy Products Div., International Nickel Co., Inc.

ROOFING, FLASHING, ZINC

Illinois Zinc Co., A Div. of Hydrometals—"HYDRO-T-METAL"

ROOFING, SIDING, ALUMINUM

Aluminum Co. of America
T. J. Moss Tie Co.
Revere Copper & Brass Inc.
Reynolds Metals Co.
G. C. Thomas Mfg. Co.

ROOFING, SIDING, ASBESTOS

Philip Carey Mfg. Co.—"4.2 CAREYSTONE"
Johns-Manville—"TRANSITE FLEX-STONE," "ADQUA-DAM"
Keasbey & Mattison Co.
The Ruberoid Co.
G. C. Thomas Mfg. Co.

ROOFING, SIDING

The Ruberoid Co.

ROOFING, SIDING, GALVANIZED

Bethlehem Steel Co.
T. J. Moss Tie Co.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
G. C. Thomas Mfg. Co.
United States Steel Corp.
The Youngstown Sheet & Tube Co.—"TUFKOTE"

ROOFING SIDING, PROTECTED METALS

G. C. Thomas Mfg. Co.

ROOFING, SIDING, ZINC

Illinois Zinc Co., A Div. of Hydrometals—(Hydro-T-Metal)

ROOTERS

LeTourneau-Westinghouse Co.

ROTOR TOOLS—See Drills, roof-bolting, rotary impact tools for

RUST-PREVENTIVE COMPOUNDS

American Minechem Co.—"CHEMPENT"
Mobile Oil Co., A Div. of Socony Mobil Oil Co., Inc.

SAFETY BELTS

E. D. Bullard Co.—"MORENCI"
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

SAFETY DISPLAYS, SIGNS

Elliott Service Co., Inc.
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.—"M-S-A"

SAFETY EQUIPMENT

Mine Safety Appliances Co.

SAFETY FOOTGEAR, LEATHER

Hu-Test Safety Shoe Div., International Shoe Co.—"HY-TEST"
Mine Safety Appliances Co.

SAFETY FOOTGEAR, RUBBER

Goodall Rubber Co.
B. F.Goodrich Footwear and Flooring Co.—'XTRATUF," (neoprene) "PREMIER"
Hood Industrial Footwear & Gloves—"SUPREX," LECTRO," (neoprene)
Mine Safety Appliances Co.

SAFETY HEADGEAR

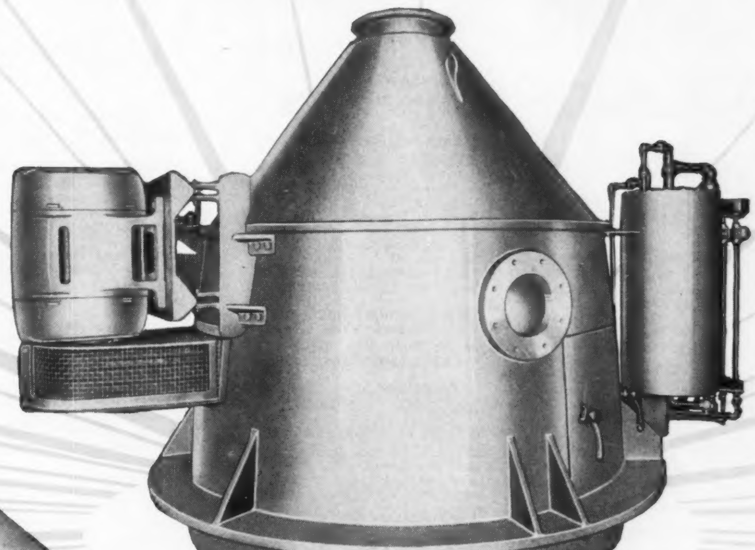
Air Reduction Sales Co., Div. of Air Reduction Co., Inc.
American Optical Co., Safety Products Div.—"DURA-GUARD"
E. D. Bullard Co.—"HARD-BOILED"
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.—SKULL-GARD," "COMFO CAP"
National Mine Service Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co. —"SAFHED"

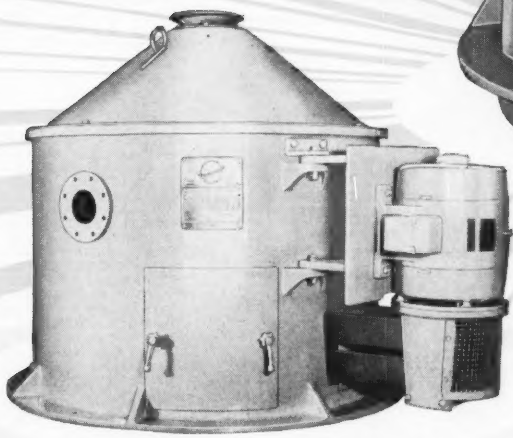
SAFETY HOOKS

E. D. Bullard Co.—"BULLARD"
Coffin Hoist Div., Duff-Norton Co.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY-LAUGHLIN"
General Scientific Equipment Co. —"GS"
Shepard Niles Crane & Hoist Corp.

FOR COMPANIES OF EVERY SIZE

CMI COAL DRYERS





The Two Most Popular Sizes of CMI Continuous Centrifugal Coal Dryers

MODEL 36 (above)—65 TPH
COMPACT 26 (left)—20 TPH

Hundreds of installations prove that best results in centrifugal coal drying are obtained with CMI Dryers. CMI performance claims are conservative and correct.

GENERAL SPECIFICATIONS	COMPACT 26	MODEL 36
Conservative rating with feed of ¼ x 0 product at 35% surface moisture	20 tph	65 tph
Percent recovery of product	over 90%	over 90%
Percent surface moisture of discharge product	under 6%	under 6%
Horsepower consumption	10-15 hp	50 hp
Total machine weight, including motor	4700 lbs.	13,000 lbs.
Floor space required	59" x 59"	71" x 76"
Overall machine height	52"	80"
Motor specifications	15 hp; 1800 rpm	50 hp; 1800 rpm

For complete information, write for literature.

CMI CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.

146 PRESIDENT STREET • ST. LOUIS 18, MISSOURI

SAFETY SIGNS, REFLECTORIZED
Mine Safety Appliances Co.—"SCOTCHLITE BRAND"

SALT
International Salt Co.—"STERLING"
Morton Salt Co.—"MORTON"

SALT, ROCK
International Salt Co.—"STERLING"

SALT, WITH RUST INHIBITOR
Diamond Crystal Salt Co.

SALT TABLETS
E. D. Bullard Co.
Morton Salt Co.—"MORTON"
Pulmosan Safety Equip. Co.
United States Safety Service Co.—"PEP-UP"

SAMPLERS, COAL
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Holmes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61
Mobile Drilling, Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sturtevant Mill Co.

SAMPLERS, COAL, AUTOMATIC
Denver Equipment Co.— "DECO"
The Galigher Co.—"GEARY JENNINGS"
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Holmes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Mine and Smelter Supply Co.—"VEZIN"
Sturtevant Mill Co.

SAND DRIERS
Barber-Greene Co.
J. D. Christian Engineers
Cowanesque Valley Iron Works—"SUTTON"
Denver Equipment Co.
The Eimco Corp.
Holmes Bros., Inc.
Iowa Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Pioneer Engineering, Div. of Poor & Co.

SANDERS, PORTABLE ELECTRIC
The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.

SAW BLADES
Disston Div., H. K. Porter Co., Inc.
Ladish Co.
Martindale Electric Co.

SAWS, BOW & BLADES
Tools Div., Trans-Atlantic Co.—"TACO SWEDISH BOW"

SAWS, PORTABLE POWER
The Black & Decker Mfg. Co.—(Electric)
Chicago Pneumatic Tool Co.
Disston Div., H. K. Porter Co., Inc.
Herold Mfg. Co.
Homelite, a div. of Textron, Inc.
Ingersoll-Rand Co.
Martindale Electric Co.
Remington Arms Co., Inc.
Thor Power Tool Co.
Vulcan Iron Works Co. (Denver)—"PORTOCUT"
Wright Power Saw & Tool Corp., Div. of Thomas Industries Inc.

SAWS, HACK
Disston Div., H. K. Porter Co., Inc.
Snap-on Tools Corp.—"SNAP-ON"

SAWS, HAND
Disston Div., H. K. Porter Co., Inc.

SCALE-WEIGHT RECORDERS
Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Howe Scale Co., Inc.—"MECHANOPRINT"
Industrial Physics & Electronics Co.
Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCALE-WEIGHT RECORDERS, CONVEYOR
Merrick Scale Mfg. Co.—"WEIGHTOMETER"

SCALES—See also CONVEYOR WEIGHERS

SCALES, MINE-CAR WEIGHING
Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Howe Scale Co., Inc.
Morse Bros. Machinery Co.
Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCALES, R. R., CAR WEIGHING
Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Howe Scale Co.
Morse Bros. Machinery Co.
Winslow Government Standard Scale Works, Inc.

SCALES, TRUCK WEIGHING
Buffalo Scale Co., Inc.
Fairbanks Morse & Co.
Howe Scale Co., Inc.
Morse Bros. Machinery Co.
Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCRAPER TIPS, TEETH
American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"

SCRAPERS, DISC-FILTER
Peterson Filters & Engineering Co.—"DUAL GUIDE," "CONTOUR"

SCRAPERS, DRAG
Jeffrey Mfg. Co.
Joy Mfg. Co.
Laubenstein Mfg. Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Sauerman Bros., Inc.—"CRESCENT"
G. C. Thomas Mfg. Co.

SCRAPERS, SELF-POWERED
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Euclid Div., General Motors Corp.
International Harvester Co.—"PAYSCRAPER"
Joy Mfg. Co.
R. G. LeTourneau, Inc.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Curtiss-Wright Corp., South Bend Div.

SCRAPERS, SHOT-HOLE
The Leetonia Tool Co.

SCRAPERS, TRACTOR-DRAWN
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
International Harvester Co.
LeTourneau-Westinghouse Co.
Curtiss Wright Corp., South Bend Div.

SCRAPERS, UNDERGROUND
The Eimco Corp.
Joy Mfg. Co.
Vulcan Iron Works Co. (Denver)—"VULCAN-DENVER"

SCREEN BARS
The Colorado Fuel & Iron Corp.—"C F & I"
Homes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Salem-Brosius, Inc.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.
Wedge Wire Corp.—"KLEEN-SLIT"

SCREEN BUCK-UP CHANNEL RUBBER
Hoyt Wire Cloth Co.

SCREEN-CLOTH HEATERS
The Deister Concentrator Co., Inc.—"FLEXELEX"
F. R. Hannon & Sons—"HANCO"
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61
Productive Equipment Corp.
Screen Equipment Co., Inc.—"HANNON"
Simplicity Engineering Co.
W. S. Tyler Co.—"TY-ELECTRIC"

SCREEN, MESH CLOTH
Cleveland Wire Cloth & Mfg. Co.
The Colorado Fuel & Iron Corp.—"C F & I", "SUPER-TEMPERED," "WISCOLOY"
Cross Perforated Metals Plant, National-Standard Co.—"RIMA"
Hendrick Mfg. Co.
Hewitt-Robins Incorporated—"GYRALOY," "SUPER GYRALOY"
Hoyt Wire Cloth Co.—"SUPERTOUGH," "ABRASO," "SUPERHARD STAINLESS STEEL," "SMOOTHTOP," "LONGSLOT," "OBLONG," "DOUBLE CRIMP"
Iowa Mfg Co.
Link-Belt Co., Dept. CAMGL-61
Ludlow Saylor Wire Cloth Co.—"ARCHCRIMP," "STA-SMOOTH," "STA-CLEAN," "STA-TRU," "REKTANG," "PERFECT" "LUDLOW"
Newark Wire Cloth Co.
Simplicity Engineering Co.
W. S. Tyler Co.—"DOUBLE-CRIMP," "TONCAP," "TY-ROD," "CORDUROY"

SCREEN PLATE, PERFORATED
Chicago Perforating Co.
Cross Perforated Metals Plant, National-Standard Co. — "CROSS," "CONIDURE," "HEXSCREEN," "CONIDURE," centrifugal
The Harrington & King Perforating Co., Inc.
Hendrick Mfg. Co.
Holmes Bros., Inc.
Iowa Mfg. Co.
Irwin Sensenich Corp.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co. Dept. CAMGL-61
Remaly Mfg. Co. Inc.
Salem-Brosius, Inc.
W. J. Savage Co.
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.

SCREEN, ROD-TYPE
Allis-Chalmers Mfg. Co.
Bixby-Zimmer Engineering Co.
Link-Belt Co., Dept. CAMGL-61
Nordberg Mfg. Co.—"SYMONS"
W. S. Tyler Co.—"TY-LOC"

SCREEN, SPACE CLOTH
Cleveland Wire Cloth & Mfg. Co.
The Colorado Fuel & Iron Corp.—"C F & I," "SUPER-TEMPERED," "WISCOLOY"
Cross Perforated Metals Plant, National-Standard Co. — "RIMA"
Hendrick Mfg. Co.
Hewitt-Robins Incorporated — "GYRALOY," "SUPER GYRALOY"
Hoyt Wire Cloth Co. — "SUPERTOUGH," "ABRASO," "SUPERHARD STAINLESS STEEL," "SMOOTHTOP," "LONGSLOT," "OBLONG," "DOUBLE CRIMP"
Iowa Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Ludlow Saylor Wire Cloth Co. — "ARCHCRIMP," "STA-SMOOTH," "STA-CLEAN," "STA-TRU," "REKTANG," "LUDLOW,' "SUPER-LOY PERFECT"
Newark Wire Cloth Co.
Simplicity Engineering Co.
W. S. Tyler Co.—"DOUBLE-CRIMP," "TON-CAP," "TY-ROD"

SCREENS, INCLINED STATIONARY
Heyl & Patterson Inc.—"H&P SIEVE BEND"
Link-Belt Co., Dept. CAMGL-61

SCREENS, WEDGE BAR, WIRE
Allis-Chalmers Mfg. Co.
Bixby-Zimmer Engineering Co.
Cross Perforated Metals Plant, National Standard Co.—"RIMA"
Hendrick Mfg. Co.—"WEDGE-SLOT"
Wedge Wire Corp.—"KLEEN-SLOT"

SCREENS—See "Screening Machines, Revolving, etc."

SCREENS, CENTRIFUGAL—See "Dryers, centrifugal" and "Centrifuges"

SCREENING MACHINES, REVOLVING
Allis-Chalmers Mfg. Co.
Denver Equipment Co.—"DENVER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hammermills, Inc.
Hendrick Mfg. Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.

Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Lippmann Engrg. Works Inc.
McLanahan Corp.
Nordberg Mfg. Co.—"SYMONS V-SCREEN"
Pioneer Engineering, Div. of Poor & Co.
W. J. Savage Co.
Smith Engineering Works — "TELSMITH"
W. S. Tyler Co.
Universal Road Machinery Co. — "RELIANCE"
Webster Mfg., Inc.

SCREENING MACHINES, SHAKER

The Colorado Fuel & Iron Corp.—"CF&I," "SUPER-TEMPERED," "WISSCOLOY"
Galis Electric & Machine Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Hoyt Wire Cloth Co.
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lauberstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McLanahan Corp.
McNally-Pittsburg Mfg. Corp.
Newark Wire Cloth Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.

SCREENING MACHINES, VIBRATING

Allis-Chalmers Mfg. Co.
Bird Machine Co.
Carrier Division, Chain Belt Co.—"CARRIER NATURAL FREQUENCY"
The Colorado Fuel & Iron Corp. Wickwire Spencer Steel Div.—"CF&I," "SUPERTEMPERED," "WISSCOLOY"
The Deister Concentrator Co., Inc.—"LEAHY HEAVY DUTY NO BLIND"
Deister Machine Co.
Denver Equipment Co.—"DENVER-DILLON"
Diamond Iron Works, Div. Goodman Mfg. Co.
Dravo Corp.
Galis Electric & Machine Co.—"LECCO-VIB"
Grundler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated—"HI-G," "VIBREX," "ELIPTEX," "GYREX," "HI-SPEED" "HYDREX" "FLIPTEX DEWATERIZER"
Heyl & Patterson, Inc.
Hoyt Wire Cloth Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Lauberstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"BA," "CA," "UP," "CL," "VC," "NRM," "CB," "CM," "SYNCHROMATIC"
Lippmann Engrg. Works Inc.
McLanahan Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engineering, Inc.—"MECKUM-SKB"
Morse Bros. Machinery Co.
Newark Wire Coth Co.
Nordberg Mfg. Co.—"SYMONS"
NoVo Div., of NOVO Industrial Corp.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.—"SUPER SERVICE MESABI"
Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Remaly Mfg. Co. Inc.
Screen Equipment Co., Inc.—"SECO"
Simplicity Engineering Co.—"SIMPLI-FLO"
Smith Engineering Works—"TELSMITH"
Stephens Adamson Mfg. Co.
Sturtevant Mill Co.
Syntron Co.
W. S. Tyler Co.—"HUMMER"

"TY-ROCK," "TYLER-NIAGARA," "TYROCKET"
Universal Vibrating Screen Co. "UNIVERSAL," "UNILEC," "UNIFLEX"
Wedge Wire Corp.—"KLEEN SLOT"

SCREENS, TESTING
Allis-Chalmers Mfg. Co.
Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
Galis Electric & Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Link,Belt Co., Dept. CAMGL-61
Newark Wire Cloth Co.
Productive Equipment Corp.
Syntron Co.
W. S. Tyler Co.—"RO-TAP," "TY-LAB"
Universal Vibrating Screen Co.—"UNIVIBE"

SCREW WASHERS
Link-Belt Co., Dept. CAMGL-61

SCRUBBERS, AIR, GAS
The Ducon Co., Inc.
The Johnson-March Corp.—"HYDRO-VOLUTE SCRUBBER"

SEALANTS
The Magichemical Co.—"MAGI-SEAL"
Sika Chemical Corp.—"SIKA EPOXY JOINT SEALER," "SIKA EPOXY CRACK SEALER," "IGAS," "SIKA QUICKSETS"

SEALS, BEARING, GREASE & OIL
Bearings, Inc.
Federal-Mogul Service, Div. of Federal-Mogul Bower Bearings, Inc.—"NATIONAL"
Garlock Inc.—"GARLOCK KLOZURE"
Johns-Manville—"CLIPPER"
United States Rubber Co.
West Virginia Armature Co.

SEALS, CARBON & GRAPHITE
Stackpole Carbon Co.

SEALS, SHAFT, MECHANICAL
Anchor Packing Co.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Garlock Inc.—"MECHANIPAK"
Koppers Co., Inc.,MetalProducts Div.
Syntron Co.
United States Rubber Co.

SECTIONAL CONVEYORS
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-6

SEISMOGRAPHS, BLASTING
Vibration Measurement Engineers, Inc.—"SEISMOLOG"

SELF-RESCUERS
Mine Safety Appliances Co.

SEPARATORS, AIR
Buell Engineering Co., Inc.
Hardinge Co., Inc.
Roberts & Schaefer Company, Division of Thompson-Starrett Company Inc.
Sturtevant Mill Co.
Universal Road Machinery Co.—"RELIANCE—GAYCO"
Williams Patent Crusher & Pulv. Co.

SEPARATORS, HEAVY-MEDIA
Link-Belt Co., Dept. CAMGL-61
WEMCO Div., Western Machinery Co.—"WEMCO CONE," "WEMCO DRUM"

SEPARATORS, METAL, MAGNETIC AND MAGNETIC CONVEYOR
Infilco Inc., Gale Separator Div. —"GALE," "FLEXIFLIGHT"

SEPARATORS, TROUGH
Link-Belt Co., Dept. CAMGL-61

SEPARATORS. VIBRATING SCREEN
Link-Belt Co., Dept. CAMGL-61
Southwestern Engineering Co.—"SWECO"

SERVICE TRUCKS, SELF PROPELLED
Schroeder Brothers Corp.

SHAFT HANGERS
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Webster Mfg., Inc.

SHAFT RIGS, PNEUMATIC
Schroeder Brothers Corp.

SHAFT-SINKING MACHINES
Shaft and Development Machine Co.—"CRYDERMAN MUCKER"

SHAFT & TUNNEL SUPPORTS
Commercial Shearing & Stamping Co. (Steel plates, ribs, sets & lagging)

SHAFTING, STEEL
Bethlehem Steel Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Joseph T. Ryerson & Son, Inc.
Transall Inc.
Bertrand P. Tracy Co.

SHAFTS, SPLINED
North American Gear Co. — "NAMCO"

SHAPES, STRUCTURAL, ALUMINUM
Aluminum Company of America
Reynolds Metals Co.

SHEAVES
Bethlehem Steel Co.

SHEAVES, HOISTING
American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
C. S. Card Iron Works
Connellsville Corp.
Holmes Bros., Inc.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford-Day Corp.
Sauerman Bros., Inc.—"DURO-LITE"
The Tool Steel Gear & Pinion Co.
Vulcan Iron Works Co. (Denver)
Wilmot Engineering Co.

SHEAVES, TRACK
C. S. Card Iron Works
Holmes Bros., Inc.
Pittsburgh Gear Co.
Sanford-Day Corp.
Sauerman Bros., Inc.—"DURO-LITE"
Vulcan Iron Works Co. (Denver)

SHEAVES, V-BELT
The American Pulley Co.—"Q-D-V," "3-5-8"
Bethlehem Steel Co.
Browning Mfg. Co.—"POLLY-V" "GEARBELT"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Dayton Industrial Products Co.—"DAYTON"
Dodge Mfg. Corp.—"TAPER LOCK," "DYNA-V"
Flood City Brass & Electric Co.
The Gates Rubber Co.
Hewitt-Robins Incorporated—"JONES"
Iowa Mfg. Co.
McLahanan Corp.
McNally-Pittsburg Mfg. Corp.
National Mine Service Co.
Ore Reclamation Co.
Pittsburgh Gear Co.
Transall, Inc.
T. B. Woods Sons Co.—"SURE-GRIP" "ULTRA-V"
Worthington Corp.

SHEAVES, WIRE-ROPE
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
C. S. Card Iron Works
Farrell-Check Steel Co.
Holmes Bros., Inc.
Joy Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford-Day Corp.
Sauerman Bros., Inc.—"DURO-LITE"
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Vulcan Iron Works Co. (Denver)
T. B. Woods Sons Co.

SHEET, CORRUGATED ALUMINUM
Aluminum Co. of America
Reynolds Metals Co.

SHELVING, RACKS, ETC.
The Frick-Gallagher Mfg. Co.—"CLIP-BILT"
National Mine Service Co.
Miners' Hardware Supply Co.—"LYONS METAL PRODUCTS"

SHIM STOCK, SHIMS
Crucible Steel Co. of America
B. F. Goodrich Industrial Products Co.

SHOCK ABSORBERS, MACHINE & MOTOR MOUNTS
Continental Rubber Works
United States Rubber Co.

SHOTFIRERS
Femco, Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.

SHOVELS—See also "Loaders"

SHOVELS, HAND
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
The Salem Tool Co.—"RED DEVIL"
The Wood Shovel & Tool Co.

SHOVELS, REVOLVING, COAL LOADING
American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus-Erie Co.
Harnischfeger Corp.
Insley Mfg. Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
Schield Bantam Co.
The Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

SHOVELS, STRIPPING
American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bucyrus Erie Co.
Harnischfeger Corp.
Insley Mfg. Corp.
Koehring Div. of Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co., a Div. of Universal Marion Corp.
Northwest Engineering Co.
The Thew Shovel Co.—"LORAIN"

SHOVELS, TRACTOR
Caterpillar Tractor Co.

SHOVELS, TRACTOR, TRACTOR-MOUNTED—See "Loaders"

SHOWER-ROOM EQUIPMENT
Onox, Inc.—"ONOX FOOT-MATS," "ONOX SKIN-TOUGHENER," "ONOX FOOTSPRAYERS"

SHUTTLE TRAINS, GANGWAY DEVELOPMENT, ELECTRIC, AIR
Herold Mfg. Co.

SIEVES, TESTING
Central Scientific Co.
Fisher Scientific Co.
Newark Wire Cloth Co.
W. S. Tyler Co.—"TYLER STANDARD-SCREEN SCALE"

SIGNALS, HAULAGE
American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

SIGNALS, HIGHWAY CROSSING
American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.
Union Switch Signal Div., Westinghouse Air Brake Co.

SIGNALS, LIGHT CASES
American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

SILOS, ASH, COAL & SAND STORAGE
Link-Belt Co., Dept. CAMGL-61
Marieta Concrete Div., American-Marietta Co.
The Neff & Fry Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Ruttmann Construction Co.

SKATES, RAIL
The Aldon Co.

SKIDS, MINE-CAR
Bethlehem Steel Co.
Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Irwin Sensenich Corp.
Miners Hardware Supply Co.
Sanford-Day Corp.

SKIP WHEELS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"

SKIPS, AUTOMATIC LOADING EQUIPMENT
Holmes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61

SKIPS, MINE-HOISTING
Connellsville Corp.
Hewitt-Robins Incorporated
Holmes Bros., Inc.
Link-Belt Co., Dept. CAMGL-61
Mayo Tunnel & Mine Equipment Co.
The Stearns-Roger Mfg. Co.
Vulcan Iron Works Co. (Denver)
Webster Mfg., Inc.

SLINGS, BELT
C. R. Daniels Co.
B. F. Goodrich Co., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Raybestos Manhattan Inc., Manhattan Rubber Div.

SLINGS, CHAIN
American Chain Div., American Chain & Cable Co., Inc.
Columbus McKinnon Corp., Mining Equipment Div.
Joseph T. Ryerson & Son, Inc.

SLINGS, WEB-BELT, WOVENWIRE
Jones & Laughlin Steel Corp.—"SAFETY-WEAVE," "J A L-MESH"

SLINGS, WIRE-ROPE
American Chain & Cable—"ACCO REGISTERED," "DUALOC"
Bergen Wire Rope Co.
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND," "B & B," "BROLOC" "THRIFT-T-LIFT"
The Colorado Fuel & Iron Corp., "WICKWIRE," "MAXIFLEX," "MULTIFLEX," "UNIFLEX," "DURAGRIP"
ESCO Corp.
Jones & Laughlin Steel Corp.—"JALFLEX"
Leschen Wire Rope Div., H. K. Porter Co., Inc.
Macwhyte Wire Rope Co.—"ATLAS," "DREW," "MONARCH," SAFE-GUARD," SAFE-LOCK"
National Mine Service Co.
John A. Roebling's Sons Div., The Colrado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Union Wire Rope, Armco Steel Corp.—"TUFFY"
The Upson-Walton Co.—"MAX-GRIP"
Wire Rope Corp. of America, Inc. —"WIRECO," "SUPER-FLEX," "WIRECO AL-GRIP," "WIRECO STEEL GRIP"

SLUDGE RECOVERY SYSTEMS
Link-Belt Co. Dept. CAMGL-61

CAT 966 WHEEL LOADERS

...working mobility for the load-and-run jobs

The stockpiles are scattered all over the Glen Alden Corporation's Wanarie No. 19 strip mine. Stripping and hauling out the anthracite coal is done by J. B. Corgan of Kingston, Pa. He needs a loader that can fill a 15 yd. truck and then run to another stockpile and load again. A power shovel couldn't give them the mobility, and a few years ago they switched to wheel loaders. Last June they switched again—to the new Cat 966.

"We picked a big 966," says Bill Corgan, "because of its fast power shift transmission, the automatic bucket controls and its safety—with the lift arms up front. The 966's dual-ratio steering is a feature that fits our job perfectly too. The operator can use that fast ratio for loading (a half-twirl of steering wheel puts the loader in full turn), then for running to another stockpile, he shifts to travel ratio (loader steers with normal automotive response). And I'd say there was one other reason for our choice of the 966—we're not strangers to Cat dependability."

Yes, it's a logical choice for jobs requiring fast moves *and* high production. With the 966's 4 yd. coal handling bucket, you're offered a loader that can give you *up to 5000 tons per day capability.* Easy operating features are behind that figure: AUTOMATIC BUCKET POSITIONERS set the digging angle, lift and hold the bucket, speed up any operator's cycle; and POWER SHIFT TRANSMISSION provides on-the-go shifting, forward and reverse, first and second speeds.

If your job calls for mobility or high production or *both*—see your Caterpillar Dealer. He'll show you the full line of Cat wheel loaders—140 HP 966, the 105 HP 944 and the 80 HP 922. And he'll show you the attachments, special material buckets, side dump buckets, snow plows and bulldozers that can equip your loader for the necessary side chores. Call your dealer today and see the loaders with production and safety features no others can match.

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

CATERPILLAR

**THE 966—
FIRST IN MOBILITY—
FIRST IN PRODUCTION**

SLUSHERS, SCRAPER

Joy Mfg. Co.
Vulcan Iron works Co. (Denver) —"VULCAN-DENVER"

SOLENOIDS

Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
General Equipment & Manufacturing Co.

SOLENOIDS, D.C. HEAVY DUTY

Cheatham Electric Switching Device Co.

SOLVENTS, CLEANING

American Minechem Co.
Cities Service Oil Co.
Columbia - Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Esso Standare Div. of Humble Oil and Refining Co.—"VARSOL"
Martindale Electric Co.
Mobil Oil Co., a Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sun Oil Co.—"SUN SPIRITS"
Wyandotte Chemicals Corp.

SPAD DRIVERS, HANGERS

American Mine Supply Co.

SPADS

American Mine Supply Co.
Black Diamond Spad Co.—"BLACK DIAMOND"
Howell Mining Drill Co.—"HOWELLS' '

SPECTACLES, SAFETY

American Optical Co., Safety Products Div.—"DURASAFE"
General Scientific Equipment Co. —"GS"
Mine Safety Appliances Co.
United States Safety Service Co. —"STYL-IZE"

SPEED INCREASERS

J. D. Christian Engineers
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co., Dept. CAMGL-61
U.S. Electrical Motors Inc. — "SYNCRO GEAR"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS

The American Pulley Co.—"SHAFT-KING," "SCREW-KING"
J. D. Christian Engineers—"RITE-LO-SPEED"
Cleveland Worm & Gear Div., Eaton Mfg. Co.—"CLEVE-LAND"
Cone-Drive Gears Div., Michigan Tool Co.
Continental Conveyor & Equipment Co.
DeLaval-Holroyd, Inc.—"DELROYD"
Dodge Mfg. Corp.—"TORQUE-ARM"
The Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Corp.—"HYGRADE," "LINE-O-POWER," "MAXI-POWER," "LINE-O-MOUNT," "SHAFT-MOUNT"
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co., Dept. CAMGL-61 —"LINK-BELT," "IN-LINE HELICAL," "PARALLEL SHAFT," "GEAR-MOTOR," "P. I. V.," "MOTOGEAR," "UNIVERSAL"
The Master Electric Co., Div. of Reliance Electric & Engr. Co.
Mining Progress, Inc.
Morse Chain Co. A Borg-Warner Industry—"EBERHARDT DENVER," "NITER BOX," "'C' FLANGE GERMOTOR," "POWER GEAR"
Reliance Electric and Eng. Co.
Stephens-Adamson Mfg. Co.—"SACO"
Sterling Electric Motors, Inc.—A Sub. of Hathaway Instruments, Inc.
Transall, Inc.
Tulsa Products Div. Vickers, Inc. —"TULSA' '
U. S. Electrical Motors Inc.—"SYNCROGEAR"
Westinghouse Electric Corp.
Worthington Corp.

SPIKE PULLERS

Gibraltar Equipment & Mfg. Co.

SPIKES, TRACK—See Rail Spikes

SPIRALS, COAL

Mining Progress, Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"

SPLICING COMPOUNDS, MATERIALS—See Conveyor Belting Splicing Materials

SPRAY COMPOUNDS

Fuel Process Co. (Inc.)—(Calcium-chloride)
The Johnson-March Corp.—"COMPOUND MR"

SPRAY OILS

American Oil Co.
Ashland Oil & Refining Co.—"ASHLAND PERMATREAT"
Cities Service Oil Co.
Esso Standard, Div. of Humble Oil and Refining Co.—"KOLAY"
Mobil Oil Co., A Div. of Socony Mobil Oil Co., Inc.
Shell Oil Co.
Sun Oil Co.—"COAL KOTE"
Texaco Inc.
Valvoline Oil Co., Div. of Ashland Oil & Refining Co.

SPRAYERS, HIGH-PRESSURE

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

SPRAYING EQUIPMENT—See also Dustproofing Equipment

SPRAYING EQUIPMENT, OIL

Keenan Oil Co.
Megator Corp.—"MEGATOR-CONFLOW"
Sanford-Day Corp.
W. J. Savage Co.—"RACINE"

SPRAYING EQUIPMENT, WATER & COMPOUNDS

American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROSPRAY ® 32 BINDER"
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
The Johnson-March Corp.
Megator Corp.—"MEGATOR-CONFLOW"

SPROCKETS

Acme Chain Co.
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Conveyor & Equipment Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER LOCK"
Farrell-Cheek Steel Co.
Helmick Foundry-Machine Co.
Illinois Gear & Machine Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-61 "LINK-BELT," "FLINT RIM," "DOUBLE DUTY," "TAPER LOCK"
McLahahan Corp.
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.—"MANGALOY"
National Mine Service Co.
North American Gear Co.—"NAMCO"
Penn Machine Co.
W. J. Savage Co.
Taylor Wharton Co. Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall, Inc.
The Whitney Chain Co., Sub. of Foote Bros. Gear & Machine Corp.
Webster Mfg., Inc.
Wilmot Engineering Co.

SPROCKETS, COAL CUTTERS

Cincinnati Mine Machinery Co.—"CINCINNATI"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Frank Prox Company, Inc.

The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.

SPROCKETS, ROLLER CHAIN

Dodge Mfg. Corp.
Flood City Brass & Electric Co.
Illinois Gear & Machine Co.
Industrial Rubber Products Co.
Link-Belt Co., Dept. CAMGL-61
Morse Chain Co., A Borg-Warner Industry

SPROCKETS, SILENT CHAIN

Link-Belt Co., Dept. CAMGL-61
"RC," "FR" Morse Chain Co., A Borg-Warner Industry

SPROCKETS, TAPER-BORE

Dodge Mfg. Corp.
Link-Belt Co., Dept. CAMGL-61

STACKERS, COAL-STORAGE

Link-Belt Co., Dept. CAMGL-61 —"PRE-BILT," "BUCKET-WHEEL," "JETSLINGERS"

STACKERS, RECLAIMERS, COAL

Barber-Greene Co.
Dravo Corp.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61
Pioneer Engineering Div. of Poor & Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

STAIR TREADS

Blaw-Knox Co., Blaw-Knox Equipment Div.
Dravo Corp.
Jones & Laughlin Steel Corp.—"JAL-TREAD," "JUNIOR JAL-TREAD"
Joseph T. Ryerson & Son, Inc.

STARTERS—See Motor Controllers, Starters

STEAM-TRACED PIPE, ALUMINUM

Aluminum Co. of America—"UNITRACE"
Reynolds Metals Co.—"DUPLEX"

STEEL FORMS, FOR TUNNEL & SHAFT LINING

Mayo Tunnel & Mine Equipment

STEEL, ABRASION-RESISTING

American Manganese Steel Div., American Brake Shoe Co. — "AMSCO"
American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
ESCO Corp.
Inland Steel Co. (medium & high hardness)
Jones & Laughlin Steel Corp.—"JALLOY AR"
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC"
Taylor-Wharton Co., Div., Harsco Corp.
United States Steel Corp.—"USS A-R"
The Youngstown Sheet and Tube Co.

STEEL, ALLOY

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Steel & Wire Div., U.S. Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
ESCO Corp.
Inland Steel Co.—"TM-HI-STEEL," "HI-MAN," "TRI-STEEL," "HI-MAN 440"
Jones & Laughlin Steel Corp.—"JALLOY S," "JALTEN"
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS," "T-1," "LUKENS LINE," "LUKENS 'T-1' TYPE A"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
Stulz-Sickles Co.—"MAN-GANAL," "STULZ-STAIN-LESS 1"
The Timken Roller Bearing Co.
United States Steel Corp.—"USS CARILLOY," "USS T-1," "USS FC," "USS SUPER-KORE," "USS CORTEN," "USS MAN-TEN," "USS TRI-TEN"

The Youngstown Sheet and Tube Co.

STEEL, CARBON

American Steel & Wire Div. U.S. Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
The Colorado Fuel & Iron Corp.—"C F & I"
Inland Steel Co.—"TI-NAMEL"
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS"
Phoenix Steel Corp., Structural & Tube Divs.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
United States Steel Corp.
The Youngstown Sheet and Tube Co.

STEEL, CORROSION-RESISTANT

Allegheny Ludlum Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Electro-Alloys Div. American Brake Shoe Co.
Inland Steel Co.—"TM-TI-CO," "PAINT-TITE"
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Lukens Steel Co.—"LUKENS STAINLESS-CLAD"
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
The Youngstown Sheet and Tube Co.

STEEL, REINFORCING

Bethlehem Steel Co.

STEEL SHEETS, HOT & COLD ROLLED

Jones & Laughlin Steel Corp.

STEEL, STAINLESS

Allegheny Ludlum Steel Corp.—"ALLEGHENY"
American Steel & Wire Div., U.S. Steel Corp.
The Colorado Fuel & Iron Corp.
Crucible Steel Co. of America
ESCO Corp.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel—"REPUBLIC ENDURO"
Joseph T. Ryerson & Son, Inc.
The Timken Roller Bearing Co.
United States Steel Corp.

STEEL, STRUCTURALS

Jones & Laughlin Steel Corp.

STEEL, TOOL

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Bethlehem Steel Co.
Crucible Steel Co. of America—"REX"
Jones & Laughlin Steel Corp.
Republic Steel—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
The Timken Roller Bearing Co.

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J. H. Fletcher & Co. (Key Type)

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Axeman-Anderson Co. — "ANTHRATUBE"

STOKERS, CHAIN-GRATE

Combustion Engineering, Inc. — "C-E"

STOKERS, SPREADER

Combustion Engineering, Inc. — "C-E"
Dayton Automatic Stoker Co.
Hoffman Combustion Engrg. Co.—"FIRITE"

STOKERS, TRAVELING GRATE

Combustion Engineering, Inc.—"C-E"

STOKERS, UNDERFEED

Auburn Foundry, Inc., Heating Div.—"AUBURN"
Canton Stoker Corp.—"CANTON"
Carpenter Heating & Air Conditioning Co.—"CARPENTER"
Combustion Engineering, Inc.—"C-E"
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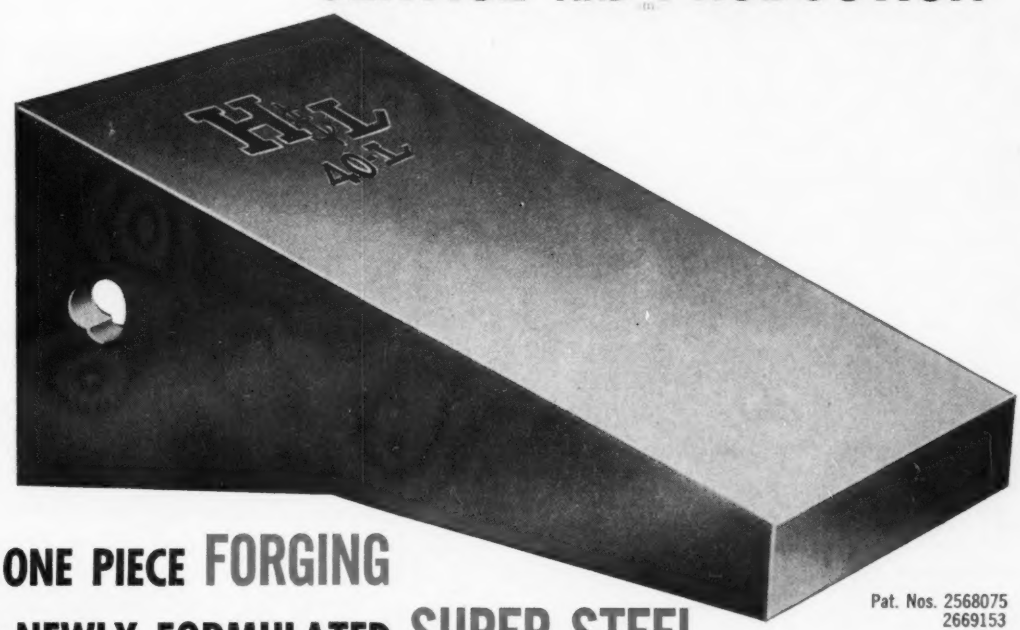

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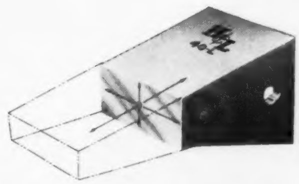

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Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD," "ALLUMOWELD"

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Delta-Star Electric Div., H. K. Porter Co., Inc.

SUBSTATIONS, OUTDOOR
Allis-Chalmers Mfg. Co.
Delta-Star Electric Div., H. K. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

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General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
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SURFACE-ACTIVE AGENTS
American Cyanamid Co., Explosives and Mining Chemicals Dept.—"AEROSOL®"
Hodag Chemical Corp.

SURVEY MARKERS
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"

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C. L. Berger & Sons, Inc.—"BERGER"
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Geo-Optic & Paper Corp.
Gurley, W. & L. E.
Wild Heerbrugg Instruments, Inc.

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American-Optical Co. Safety Products Div.
Flexo Products Inc.—"SPONGE-AIRE"
Pulmosan Safety Equip. Co.

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J. H. Fletcher & Co.

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Cutler Hammer Inc.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

SWITCH BOXES
Joy Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Div., H. K. Porter Co., Inc.
Westinghouse Electric Corp.

SWITCHGEAR
Allis-Chalmers Mfg. Co.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Herbert S. Littlewood
Westinghouse Electric Corp.

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Atkinson Armature Co.

SWITCH HOUSES
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Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

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LeTourneau-Westinghouse Co.—"SWITCH MOBILE" "SWITCH-TRACTOR"

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SWITCHES, BELT-CONTROL
General Equipment & Manufacturing Co.
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SWITCHES, CENTRIFUGAL
Ensign Electric & Mfg. Co.

SWITCHES, CONTROL, MOTORMAN-OPERATED
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Nachod & U.. S. Signal Co.

SWITCHES, CONVEYOR-BELT STOP
Cheatham Electric Switching Device Co.

SWITCHES, CONVEYOR-CONTROL
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRIC HAND
Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

SWITCHES, ELECTRICAL
Circuit Protective Devices Dept., General Electric Co.
Clark Controller Co.
Cutler-Hammer, Inc.—"C-H"
Delta-Star Electric Div., H. K. Porter Co., Inc.
The Elreco Corp.—"POWER"
G & W Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Ohio Brass Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
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SWITCHES, ELECTRICAL SAFETY
Circuit Protective Devices Dept., General Electric Co.
Cutler-Hammer, Inc.—"C-H"
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Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Westinghouse Electric Corp.

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Shepard Niles Crane & Hoist Corp.

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Circuit Protective Devices Dept., General Electric Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
The Post Glover Electric Co.—"P-G"

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Durakool, Inc.
Joy Mfg. Co.
The Post Glover Electric Co.—"P-G"

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Cheatham Electric Switching Devices Co.
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SWITCHES, THERMOCOUPLE
West Instrument Corp.

SWITCHTHROWERS
See Rail Switchthrowers

TABLE DECKS, WASHING
Linatex Corp. of America

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Galis Electric & Machine Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.—"SUPER-AIRFLOW"

TABLES, COAL-WASHING
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The Deister Concentrator Co., Inc.—"SUPER DUTY NO. 7 DIAGONAL DECK," "CONCENCO '77' DIAGONAL DECK"
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Link-Belt Co., Dept. CAMGL-61
Mine and Smelter Supply Co.—"WILFLEY"

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Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Stewart-Warner Corp., Alemite Div.
Westinghouse Electric Corp.

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Gar Wood Industries, Inc.
Hendrickson Mfg. Co.
Schroeder Brothers Corp.
Twin Disc Clutch Co.
Tulsa Products Div. Vickers, Inc.—"TULSA"

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Barber-Greene Co.
Bearings, Inc.
Chain Belt Co., Shafer Bearing Div.—"SHAFER SELF-ALIGNING"
J. D. Christian Engineers
Dodge Mfg. Corp.
Goodman Mfg. Co.
Hewitt-Robins, Incorporated
Irwin-Sensenich Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
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J. H. Fletcher & Co.

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Schroeder Brothers Corp.

TAMPERS, SHOTHOLE
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TAMPING BAGS—See Bags, Tamping

TAMPING PLUGS
National Mine Service Co.

TAMPING POLES, HEADS
The Salem Tool Co.—"McCARTHY"

TAMPING POLES, SECTIONAL
Trojan Powder Co.

TAMPING STICKS, WOOD
Duquesne Mine Supply Co.
J. V. Hammond Co.
National Mine Service Co.
National Powder Co.
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Denver Equipment Co.—"DENVER"
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Denver Equipment Co.—"DENVER"
The Galigher Co.
The Gates Rubber Co.
B. F. Goodrich Industrial Products Co.
Linatex Corp. of America
Raybestos Manhattan Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.

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Bethlehem Steel Co.
The Daniels Co.
Denver Equipment Co.—"DENVER"
Enterprise Wheel & Car Corp.
Kanahwa Mfg. Co.
Koven Fabricators, Inc.
Phoenix Steel Corp., Structural & Tube Divs.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
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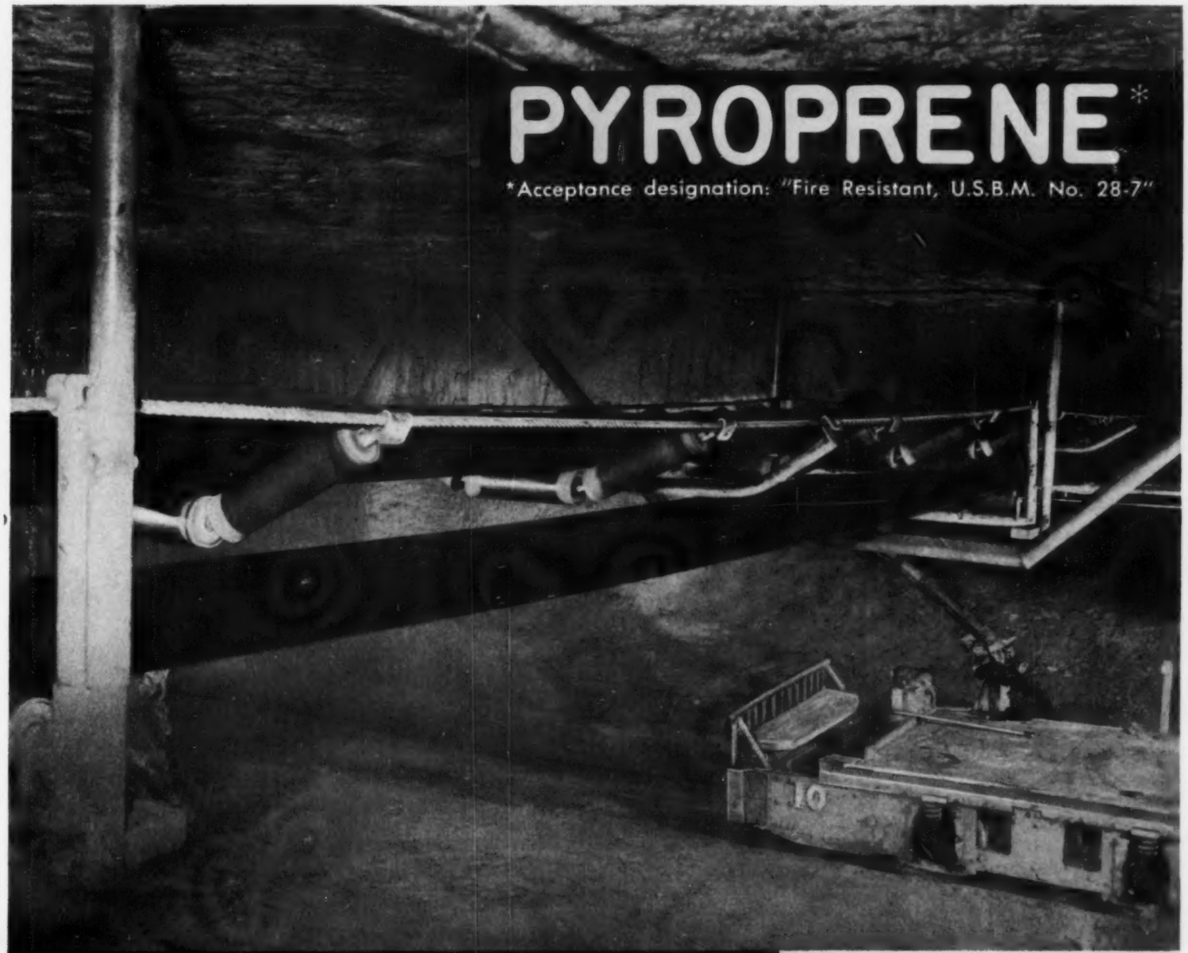
Plymouth Rubber Co., Inc.—"SLIPKNOT"

TAPE, ELECTRICAL, PLASTIC
American Biltrite Rubber Co. Boston Woven Hose & Rubber Co., Div.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOL-FAST"
Goodall Rubber Co.



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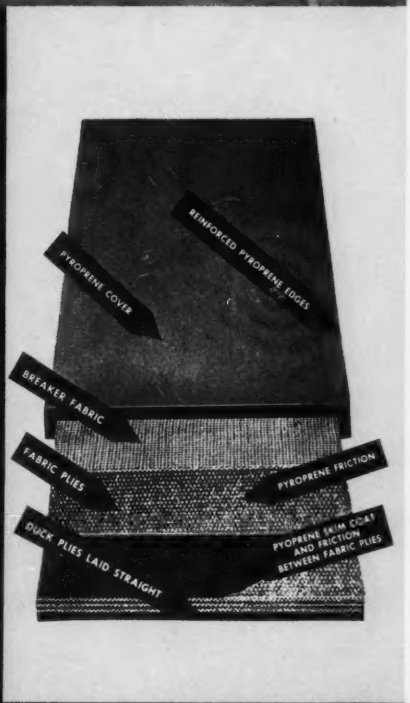

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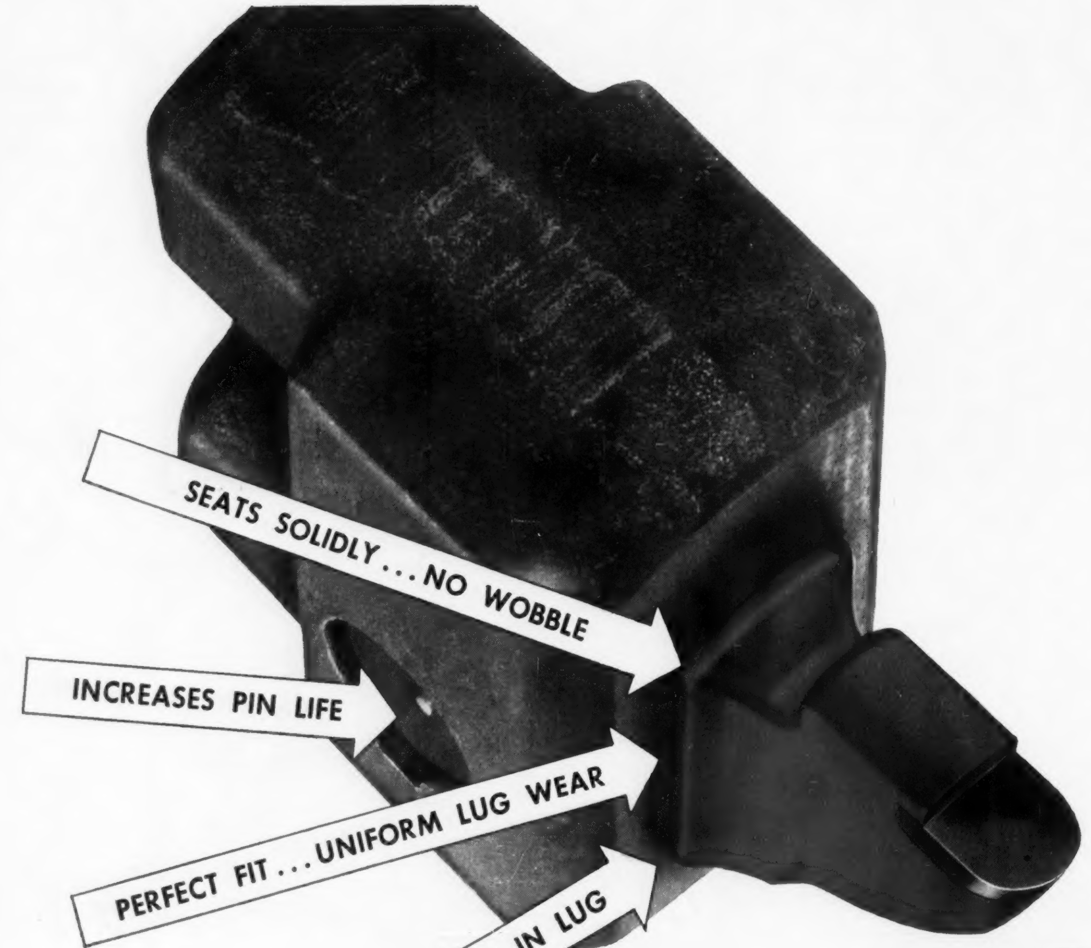

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TAPE, FRICTION
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Continental Rubber Works
Dayton Industrial Products Co.—"HOLFAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Johns-Manville—"4-STAR" "DUTCH BRAND"
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National Electric Co. Div. of McGraw-Edison Co.
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"SLIPKNOT"
The Ruberoid Co.
United States Rubber Co.
West Virginia Armature Co.

TAPE, GLASS-CLOTH
Johns-Manville—"DUTCH BRAND"
National Electric Coil Div. of McGraw-Edison Co.—"MICA-GLAS"

TAPE, GLASS-CLOTH, COATED
Irvington Div. of Minnesota Mining & Mfg. Co.—"FIBRE-MAT"

TAPE, INSULATING, IRRADIATED POLYETHYLENE
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.—"V-C IRRATHANE, MICAMAT"

TAPE, NEOPRENE
Plymouth Rubber Co., Inc.—"PLYMPRENE"

TAPE, OZONE-RESISTANT
Plymouth Rubber Co., Inc.—"PLYMOZONE"

TAPE, PAPER
Minnesota Mining & Mfg. Co.—"SCOTCH"

TAPE, POLYETHYLENE
Dayton Industrial Products Co.—"HOLFAST"

TAPE, PRESSURE-SENSITIVE
Johns-Manville—"DUTCH BRAND"

TAPE, RUBBER
American Biltrite Rubber Co., Boston Woven Hose & Rubber Co., Div.—"BULL DOG"
Continental Rubber Works
Dayton Industrial Products Co.—"HOLFAST"
Goodall Rubber Co.
Johns-Manville—"DUTCH BRAND"
Mosebach Electric & Supply Co.
National Electric Coil Div. of McGraw-Edison Co.
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"P. R."
Thermoid Div., H. K. Porter Co., Inc.
United States Rubber Co.
West Virginia Armature Co.

TAPE, VARNISHED-CAMBRIC
Irvington Div. of Minnesota Mining & Mfg. Co.
National Electric Coil Div. of McGraw-Edison Co.
Minnesota Mining & Mfg. Co.—"IRVINGTON," "FIBREMAT," "IVY-BIND," "IRVINGTON" (arc-proofing tapes & blankets)

TAPE, VINYL PLASTIC
Dayton Industrial Products Co.—"HOLFAST"
Thermoid Div., H. K. Porter Co., Inc.

TAPE, VULCANIZING
American Mine Door Co.

TAPES, MEASURING
Charles Bruning Co., Inc.
Disston Div., H. K. Porter Co., Inc.
Lufkin Rule Co.

TAPS, CABLE & TROLLEY, FUSED
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mining Machine Parts, Inc.—"MMP JABCO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TARPAULINS
C. R. Daniels Co.
Fulton Cotton Mills—"FULTEX," "FULTON," "SHUREDRY"

TELEPHONES, BATTERY
Crouse-Hinds Co.

TELEPHONES, LOUDSPEAKING MINE
Femco, Inc.
National Mine Service Co.—"FEMCO"

TELEPHONES, SOUND-POWERED
Crouse-Hinds Co.
Mining Progress, Inc.
Wheeler Electronic Corp., Sub. of Sperry Rand Corp.—"WHEELER"

TELEPHONES, TROLLEY
Femco, Inc.
National Mine Service Co.—"FEMCO"

TELEVISION SYSTEMS
Diamond Electronics, Div. of Diamond Power Specialty Corp.—"UTILISCOPE"
General Electric Co., Communication Products Dept.
Motorola Communications & Electronics, Inc.

TEMPERATURE INDICATORS, CONTROLLERS
B-I-F Industries, Inc.—"CHRONOFLO" k
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co. Apparatus Sales Div.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division—"GUARDSMAN-VERI-TELL"
West Instrument Corp.
Westinghouse Electric Corp.

TEST STANDS, HYDRAULIC
Schroeder Brothers Corp.—"UNIVERSAL"

TESTERS, CARBON MONOXIDE
Mine Safety Appliances Co.
United States Safety Service Co.—'SAF-CO-METER"

TESTERS, INSULATION
The Electrical Distributors Co.
The Hewson Co.—"TAKK," "VON"
Martindale Electric Co.

TESTERS, INSULATORS
I-T-E Circuit Breaker Co.

TESTERS, PORTABLE HYDRAULIC
Schroeder Brothers Corp.—"PT-50-B"

TESTERS, RAIL-BOND
Mosebach Electric & Supply Co.
Ohio Brass Co.

TESTERS, VOLTAGE
Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Holub Industries, Inc.
I-T-E Circuit Breaker Co.
Martindale Electric Co.
Westinghouse Electric Corp.

THEODOLITES
W. & L. E. Gurley
Kern Instruments, Inc. (optical)

THERMISTORS
Keystone Carbon Co.

THERMOCOUPLES
The Bristol Co.—"BRISTOLS'S"
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.

THICKENERS
Denver Equipment Co.—"DENVER-STANDARD," "DENVER HEAVY-DUTY AUTOMATIC"
Dorr-Oliver, Incorporated
The Eimco Corp.
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
WEMCO Div., Western Machinery Co.—"WEMCO"

THICKENING, STABILIZING, SUSPENDING AGENTS
B. F. Goodrich Chemical Co.—"GOOD-RITE CARBOPAL 934"

THICKENERS, VACUUM FILTER
Peterson Filters & Engineering Co.—"ROTO-DISC"

THINNERS, INSULATING PAINT, VARNISH
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.

THROTTLE CONTROLS
Link-Belt Speeder Corp.—"SPEED-O-TROL"

TIES—See "Rail Ties"

TIMBER—See also Roof Supports, Yieldable Arch

TIMBER, TREATED
Koppers Co., Inc. Wood Preserving Div. (Creosoted and "WOLMANIZED"
Mining Progress, Inc.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.

TIMBER FRAMERS
Denver Equipment Co.—"DENVER"
Stearns-Roger Mfg. Co.

TIMBER PULLERS
Templeton, Kenly & Co.—"SIMPLEX"

TIMBER-TREATING MATERIALS
Darworth, Inc., Chemical Products Div.—"CUPRINOL"
The Dow Chemical Co.
Monsanto Chemical Co.
Osmose Wood Preserving Co.—"OSMOSALTS, OSMO-PLASTICS, M-T-M"

TIMBERING MACHINES
Goodman Mfg. Co.

TIMERS, MERCURY
Durakool, Inc.
Joy Mfg. Co.

TIRE RECAPPING, REPAIRING
Automatic Vulcanizers Corp.

TIRES, MINE
Firestone Tire & Rubber Co.
The General Tire & Rubber Co.
Mitchell Industrial Tire, Inc.—"MITCO TROUBLE FREE"

TIRES, TRUCK & INDUSTRIAL
Dayton Industrial Products Co.—"THOROBRED"
Firestone Tire & Rubber Co.
The Gates Rubber Co.
The General Tire & Rubber Co.
B. F. Goodrich Tire Co., a Div. of The B. F. Goodrich Co.
Goodyear Tire & Rubber Co.
Seiberling Rubber Co.—"POWER LUG," "TRACTION LUG PL," POWER RIB" "T. L. TRAIL-ER," "EARTHMOVER," "POWERLUG," "COMMUT-ER" "GRADER," "STUDDED M & S"
United States Rubber Co.

TIRES, STEEL
National Mine Service Co.
Bertrand P. Tracy Co.

TIRES, STEEL TURNING
Leman Machine Co.

TOOLS, ELECTRICAL-CONNECTOR
Burndy Corp.—"HYTOOLS," "HYPRESSES"
Erico Products, Inc.—"CAD-WELD"
Joy Mfg. Co.

TOOLS, HAND
Owatonna Tool Co.
Proto Tool Co., Div. of Pendleton Tool Industries, Inc.

TOOLS, HAND, SPARK-RESISTING
Ampco Metal, Inc.

TOOLS, MECHANICS
Bearings, Inc.
Disston Div., H. K. Porter Co., Inc.
Snap-on Tools Corp.—"SNAP-ON"

TOOLS, PORTABLE
The Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Martindale Electric Co.
Penn Machine Co.
Joseph T. Ryerson & Son, Inc.
Schramm, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp. "SNAP-ON"
Syntron Co.
Thor Power Tool Co.
Worthington Corp.

TOOLS, POWDER-POWERED
Mine Safety Appliances Co.—"VELOCITY-POWER"
Remington Arms Co., Inc.—"REMINGTON STUD DRIVER"

TOOLS, TRACK
The Aldon Co.
Gibraltar Equipment & Mfg. Co.—"GEMCO TRU-BLUE"
The Leetonia Tool Co.

TORCHES & ELECTRODES, METAL-REMOVAL
The Arcair Co.

TORQUE CONVERTERS
Clark Equip. Co., Automotive Div.—"CLARK"
National Supply Div., Armco Steel Corp.—"NATIONAL"
Rockwell-Standard Corp.,—Transmission and Axle Div., "HYDRA-DRIVE"
Twin Disc Clutch Co.

TORQUE CONVERTERS, INDUSTRIAL
Fuller Transmission Div., Eaton Mfg. Co.

TOWBOATS
Dravo Corp.
Marietta Manufacturing Co.
Wiley Mfg. Co.

TOWERS, BARGE-UNLOADING
Dravo Corp.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61
Roberts & Schaefer Company Division of Thompson-Starrett Company, Inc.
Stephens-Adamson Mfg. Co.

TOWERS, HYDRAULIC
Mobile Aerial Towers, Inc.—"HI-RANGER"

TOWERS, LOADING
Link-Belt Co., Dept. CAMGL-6 1

TRACK BRACES
Gibraltar Equipment & Mfg. Co.

TRACK CLEANERS
American Mine Door Co.—"CANTON"

TRACKWORK
Bethlehem Steel Co.
H. K. Porter Co., Connors Steel Div.—"WEST VIRGINIA"

TRACTOR-COMPRESSOR UNITS
Le Roi Div., Westinghouse Air Brake Co.—"TRACTAIR"

TRACTOR GROUSER BARS
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Steel Foundries—"WEARPACT"
Kensington Steel, Div. of Poor & Co.

TRACTOR POWER-CONTROL UNITS
Caterpiller Tractor Co.
Le Tourneau-Westinghouse Co.

TRACTOR SPROCKET RIMS, MANGANESE
Kensington Steel, Div. of Poor & Co.

TRACTORS, CRAWLER
Allis-Chalmers Mfg. Co.
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.
The Eimco Corp.
Euclid Div., General Motors Corp.
International Harvester Co.
Oliver Corp.—"OLIVER"

TRACTORS, CRAWLER, UNDERGROUND
Allis-Chalmers Mfg. Co.
Caterpillar Tractor Co.
The Eimco Corp. (Air or A.C.)
International Harvester Co.

TRACTORS, RUBBER-TIRED UNDERGROUND
Fred's Welding Service
Kersey Manufacturing Co., Inc. (including permissible USBM approved)
Long-Airdox Co.
Motor Exchange and Supply Co.

TRACTORS, TRUCK-HAULAGE
Autocar Div., The White Motor Co.
FWD Corp.
Henrickson Mfg. Co.
International Harvester Co.
KW-DART Truck Co.
Mack Trucks, Inc.
Reo Div., The White Motor Co.

TRACTORS, WHEELED
Allis-Chalmers Mfg. Co.
Autocar Div., The White Motor Co.
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.
FWD Corp.—"BLUE OX"
The Frank G. Hough Co.
International Harvester Co.
R. G. LeTourneau, Inc.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR"
Oliver Corp.—"OLIVER"

TRAILER AXLES
Clark Equip. Co., Automotive Div.—"CLARK"

TRAILER BODIES
Baughman Mfg. Co., Inc.
Galion Allsteel Body Co.
Hercules Steel Products Co.
Perfection Steel Body Co.
Winter-Weiss Co.

TRAILERS, BOTTOM-DUMP
Athey Products Corp.
Euclid Div., General Motors Corp.
The Heil Co., TEC Div.—"HEIL-TEC"
Perfection Steel Body Co.
Sanford-Day Corp.

TRAILERS, END-DUMP
Hercules Steel Products Co.

TRAILERS, SIDE-DUMP
Athey Products Corp.
The Heil Co., TEC Div.—"HEIL-TEC"
Perfection Steel Body Co.
Truck Engineering Corp.

TRAILERS REAR-DUMP
Athey Products Corp.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
The Heil Co., TEC Div.—"HEIL-TEC"
Hercules Steel Products Co.
Perfection Steel Body Co.
Truck Engineering Corp.

TRAILERS, SEMI, BOTTOM-DUMP
The Heil Co., TEC Div.— "HEIL-TEC"
Hockensmith Corp.
KW-Dart Truck Co.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.

TRAILERS, SEMI, SIDE-DUMP
The Heil Co., TEC Div.—"HEIL-TEC"
Hockensmith Corp.
Marion Metal Products Co.
Perfection Steel Body Co.

TRAILERS, SEMI, REAR-DUMP
The Heil Co., TEC Div.—"HEIL-TEC," "HY-TEC," "HY-SPILL"
Hercules Steel Products Co.
Hockensmith Corp.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.

TRAMWAY TRACK STRAND, LOCKED-COIL
American Steel & Wire Div., United States Steel Corp.

TRANSFER CASES
Clark Equip. Co., Automotive Div.
FWD Corp.
Timken Detroit Axle a Div., Rockwell Spring & Axle Co.
Rockwell-Standard Corp., Transmission & Axle Div.

TRANSFORMER STATIONS, PORTABLE
Ensign Electric & Mfg. Co.

TRANSFORMER, CONTROL, INSTRUMENT
Allis-Chalmers Mfg. Co.
General Electric Co., Apparatus Sales Div.
Hevi-Duty Electric Co., A Div. of Basic Products Corp.
Kuhlman Electric Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSFORMERS, POWER
Allis-Chalmers Mfg. Co.
Atkinson Armature Works
Delta-Star Electric Div., H. K. Porter Co., Inc.
General Electric Co., Apparatus Sales Div.
F. R. Hannon & Sons—"HANCO"
Hevi-Duty Electric Co., A Div. of Basic Products Corp.
I-T-E Circuit Breaker Co.
Kuhlman Elec. Co.
Herbert S. Littlewood
Moloney Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Wagner Electric Corp.
Westhinghouse Electric Corp.

TRANSITS, ENGINEER'S
Gurley, W. & L. E.

TRANSMISSION-BELTING FASTENERS
Crescent Fastener Co. "CRESCENT"

TRANSMISSIONS
Rockwell-Standard Corp., Transmission and Axle Div.—"HYDRA-DRIVE," "POWER-SHIFT"

TRANSMISSIONS, AUTOMOTIVE
Allison Div., General Motors Corp.—"TORQMATIC" (for off-highway) Fully Automatic (for off-highway)
Clark Equip. Co., Automotive Div.—"CLARK"
Fuller Transmission Div., Eaton Mfg. Co.

TRANSMISSIONS, AUXILIARY
Fuller Transmission Div., Eaton Mfg. Co.

TRANSMISSIONS, INDUSTRIAL
Clark Equipment Co., Automotive Div.—"CLARK"
Fuller Transmission Div., Eaton Mfg. Co.

TRANSMISSIONS, POWER SHIFT
Twin Disc Clutch Co.

TRANSMISSIONS, REVERSING
The Snow-Nabstedt Gear Corp.

TRANSMISSIONS, VARIABLE SPEED
Allis-Chalmers Mfg. Co.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-61—"P.I.V.," "R.S.V.I.P."
Reeves Pulley Co., Div. The Reliance Electric & Engineering Co.—"VARI-SPEED"

TREADPLATE, ALUMINUM, ABRASIVE
Aluminum Co. of America
Reynolds Metals Co.

TRIP FEEDER-RETARDERS, HOLDERS
The Nolan Co.

TRIP LAMPS
Concordia Electric Co.—"CEAG"
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Mine Safety Appliances Co.—EDISON R-4"
National Mine Service Co.

TROLLEY CLAMPS
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY-CONTACT DEVICES, SLIDE-OPERATED
Cheatham Electric Switching Device Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

TROLLEY CONTRACTORS, PROXIMITY, MECHANICAL
General Equipment & Mfg. Co.

TROLLEY, CONVEYOR
Link-Belt Co., Dept. CAMGL-61

TROLLEY FROGS
Cheatham Elec. Switching Device Co.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY GUARDS
American Brattice Cloth Corp.
Ensign Electric & Mfg. Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Mosebach Electric & Supply Co.
National Mine Service Co.
Mine Safety Appliances Co.
Raybestos Manhattan Inc., Manhattan Rubber Div.
United States Rubber Co.

TROLLEY HANGERS
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY HARPS, SHOES, SLIDERS
American Mine Door Co.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
General Equipment & Manufacturing Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.

TROLLEY-LINE MATERIAL
National Mine Service Co.

TROLLEY POLES, WOOD
Duquesne Mine Supply Co.
Flood City Brass & Electric Co.
J. V. Hammond Co.

TROLLEY SIGNAL SYSTEMS
American Mine Door Co.
General Equipment & Manufacturing Co.
Nachod & U. S. Signal Co.

TROLLEY SPLICES
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
West Virginia Armature Co.

TROLLEY SYSTEMS
The Elreco Corp.—"ELRECO"
Ohio Brass Co.

TROLLEY TAPS—See Taps, Cable & Trolley

TROLLEY WHEELS
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.
Pittsburgh Gear Co.

TROLLEY WHEELS, CONVEYOR
Link-Belt Co., Dept. CAMGL-61

TROLLEYS, I-BEAM
Coffing Hoist Div., Duff-Norton Co.

TROWELS
Disston Div., H. K. Porter Co., Inc

TRUCK AXLES
Eaton Mfg. Co., Axle Div.
Ford Div. of Ford Motor Co.
FWD Corp.

TRUCK AXLES, DRIVING
Ford Div. of Ford Motor Co.
FWD Corp.

TRUCK BODIES
Baughman Mfg. Co., Inc.
Ford Div. of Ford Motor Co.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
The Heil Co., TEC Div.—"HEIL"
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marion Metal Products Co.
Perfection Steel Body Co.

TRUCK-BODY FLOORS, ALUMINUM
Revere Copper & Brass, Inc.
Reynolds Metals Co.

TRUCK BOGIES
Clark Equip. Co., Automotive Div.—"CLARK"
Ford Div. of Ford Motor Co.
FWD Corp.
Hendrickson Mfg. Co.

TRUCK COVERS
Bemis Bros. Bag Co.

TRUCK DRIVES, TANDEM-AXLE
Eaton Mfg. Co., Axle Div.
Ford Div. of Ford Motor Co.
Hendrickson Mfg. Co.

TRUCKS, AUTOMOTIVE
Autocar Div., The White Motor Co.
Chevrolet Motor Div.—Dodge Div., Chrysler Corp.—"DODGE"
Ford Div. of Ford Motor Co.
FWD Corp.
GMC Truck & Coach, General Motors Corp.
Hendrickson Mfg. Co.
International Harvester Co.
International Harvester Co., Motor Truck Div.—"INTERNATIONAL"
Koehring Div. of Koehring Co.—"DUMPTOR"
Mack Trucks, Inc.
Reo Div., The White Motor Co.

TRUCKS, MINE-CAR
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin Sensenich Corp.
Kanawha Mfg. Co.
National Castings Co.—"NATIONAL NC-1"
Sanford-Day Corp.

TRUCKS, MINE-LOCOMOTIVE
Penn Machine Co.

TRUCKS, OFF-HIGHWAY
Autocar Div., The White Motor Co.
Euclid Div., General Motors Corp
GMC Truck Coach, General Motors Corp.
International Harvester Co.—"PAYHAULER"
KW-Dart Truck Co.

R. G. LeTourneau, Inc.
LeTourneau-Westinghouse Co.—"HAULPAK"

TUBING, ALUMINUM

Reynolds Metals Co.
Joseph T. Ryerson & Son, Inc.

TUBING AND TUBE FITTINGS

Anchor Coupling Co., Inc.

TUBING, ELECTRICAL, MECHANICAL

General Electric Co., Conduit Products Dept.
Rome Cable, Div. of Alcoa
The Youngstown Sheet and Tube Co.

TUBING, PLASTIC AND COATED

Irvington Div. of Minnesota Mining & Mfg. Co.
Joseph T. Ryerson, & Son Inc.

TUBING, SEAMLESS-STEEL

Bethlehem Steel Co.
National Tube Div., U. S. Steel Corp.—"USS NATIONAL"
Joseph T. Ryerson & Son, Inc.
The Timken Roller Bearing Co.

TUBING, STAINLESS-STEEL

Crucible Steel Co. of America
National Tube Div., United States Steel Corp.—"USS"

TUBING, STAINLESS STEEL & HIGH ALLOY

Crucible Steel Co. of America

TUBING, STEEL

Joseph T. Ryerson & Son, Inc.

TUBING, STEEL, WELDED

Jones & Laughlin Steel Corp.

TURNBUCKLES

Bethlehem Steel Co.
Crosby-Laughlin Div., American Hoist& Derrick Co.—"CROSBY-LAUGHLIN"
Duquesne Mine Supply Co.
Ohio Brass Co.
Jseph T. Ryerson & Son, Inc.
The Upson-Walton Co.

TURNBUCKLES, INSULATED

The Elreco Corp.

TURNERS, WHEEL-FLANGE & TREAD

Transall, Inc.

UNIVERSAL JOINTS

Twin Disc Clutch Co.

UNLOADERS, MINE-CAR, R.R. CAR, BOAT

Clyde Iron Works, Inc.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61

USED EQUIPMENT (See Searchlight Advertising Section, this issue)

UTILITY VEHICLES, BATTERY-POWERED

Kersey Mfg. Co., Inc.
Long-Airdox Co.

V-BELT FASTENERS

Flexible Steel Lacing Co.—"ALLIGATOR V" "FLEX V"

VACUUM CLEANING, SWEEPING EQUIPMENT

The Black & Decker Mfg. Co.
Martindale Electric Co.

VALVE ACTUATORS, CYLINDER

Ledeen Mfg. Co.

VALVE REFACERS & GRINDERS

The Black & Decker, Mfg. Co.—"UIBRO-CENTRIC"

VALVE REPAIRS

Leman Machine Co.

VALVES, AIR

Hunt Valve Co., Div. of IBEC—"QUICKAS WINK"

VALVES, CHECK

The Allen-Sherman-Hoff Pump Co.—"FLEX-CHECK," "RUBBER LINED"

Barrett, Haentjens & Co.
Crane Co.
ESCO Corp.
The Fairbanks Co.
Farris Flexible Valve Corp.—"FLEX VALVE," "SUPER SEAL"
Goyne Pump Co.
Jenkins Bros.
Kennedy Valve **Mfg.** Co.
Ludlow Valve Mfg. Co., Inc.—"RENSSELAER"
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Bros. Corp.
Walworth Co.

VALVES, CONTROL

A. W. Cash Co.
Crane Co.

VALVES, DIAPHRAGM

The Bristol Co.—"SYNCHRO-VALVES"
A. W. Cash Valve Mfg. Co.
The Duriron Co., Inc.
Foxboro Co.
Grinnell Co.—"GRINNELL-SAUNDERS"
Minneapolis-Honeywell Regulator Co., Industrial Division

VALVES, FOOT

Crane Co.
Flood City Brass & Electric Co.
Ledeen Mfg. Co.
Walworth Co.

VALVES, GATE

Crane Co.
ESCO Corp.
The Fairbanks Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Ludlow Valve Mfg. Co., Inc.—"LUDLOW," "RENSSELAER"
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Stephens-Adamson Mfg. Co.—"TWISTITE"
Walworth Co.

VALVES, GLOBE

Crane Co.
ESCO Corp.
The Fairbanks Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.

VALVES, HYDRAULIC—See "Hydraulic Valves"

VALVES, HYDRAULICALLY OPERATED

Ludlow Valve Mfg. Co., Inc.—"LUDLOW" "RENSSELAER"

VALVES, MOTOR-OPERATED

Allis-Chalmers Mfg. Co.
The Bristol Co.
ESCO Corp.
Farris Flexible Valve Corp.—"FLEX VALVE," "SUPER SEAL"
Foxboro Co.
Homestead Valve Mfg. Co., "HOMESTEAD "
Kennedy Valve Mfg. Co.
S. P. Kinney Engineering, Inc.
Ludlow Valve Mfg. Co., Inc.—"LUDLOW," "RENSSELAER"
Midland Pipe & Supply Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
R-P & C Valve Div., American Chain & Cable Co., Inc.
Rockwell Mfg. Co.—"ROCK-WELL-NORDSTROM"
Walworth Co.
Western Precipitation Div., Joy Mfg. Co.—"TYPE R-1," "FLOATING-SEAL"

VALVES, NEEDLE

Allis-Chalmers Mfg. Co.
The Fairbanks Co.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div. American Chain & Cable Co. Inc.
Schroeder Brothers Corp.
Walworth Co.

VALVES, ORIFICE

Galis Electric & Machine Co.

VALVES, PINCH

The Daniels Co.
Farris Flexible Valve Corp. "FLEX VALVE," "SUPER SEAL"
The Galigher Co.—"GALIGHER SQUEEZE"
Linatex Corp. of America
Mine and Smelter Supply Co.—"MASSCO-GRIGSBY"
Red Jacket Co., Inc.—"RED JACKET"

VALVES, PLUG

Allis-Chalmers Mfg. Co.
Ampco Metal, Inc.
Barrett, Haentjens & Co.
Crane Co.
The Duriron Co., Inc.
Homestead Valve Mfg. Co. "HOMESTEAD "
S. P. Kinney Engineers, Inc.
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Rockwell Mfg. Co.—"ROCK-WELL," "NORDSTROM"

VALVES, PUMP

American Manganese Steel Div. American Brake Shoe Co.—"AMSCO"
Anchor Packing Co.
ESCO Corp.

VALVES, RELIEF

A. W. Cash Co.

VALVES, SAFETY

A. W. Cash Valve Mfg. Corp.
Bethlehem Steel Co.

VALVES, UNLOADER, PILOT, AIR COMPRESSORS

A. W. Cash Valve Mfg. Corp.
R. Conrader Co.

VARNISHES, INSULATING

Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.
Jeffrey Mfg. Co.
Martindale Electric Co.
Minnesota Mining & Mfg. Co.—"IRVINGTON," "BRAND "HARVEL" BRAND
National Mine Service Co.
Pennsylvania Electric Coil Corp.

VENTILATING, TUBING

American Brattice Cloth Corp.—"MINEVENT, MINE DUCT"
Bemis Bros. Bag Co.—"FLEXIPIPE"
Flexaust Co.—"PORTOVENT"

VENTILATION SURVEYING EQUIPMENT

American Paulin System—"MICRO," "TERRA"

VIBRATION ABSORBERS

Cobra Metal Hose, Div. D K Mfg. Co.

VIBRATION DAMPERS, RUBBER

Goodyear Tire & Rubber Co.
Raybestos Manhattan, Inc. Manhattan Rubber Div.

VIBRATION MEASUREMENT, BLASTING

W. F. Sprengnether Instrument Co., Inc.
Vibration Measurement Engineers Inc.—"SEISMOLOG"

VIBRATORS, BIN & HOPPER

The Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eriez Manufacturing Co.
Hewitt-Robins Incorporated "VIBROLATOR"
Martin Engineering Co.—"VIBROLATOR," "MOTO-MAGNETIC"
National Air Vibrator Co.
Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.—"TY-SPEED"
Viber Co.—"AIROVIBER," "VIBERLEC," "MODEL PX" "TURBOVIBER"

VIBRATORS, CHUTE

The Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Martin Engineering Co.—"VIBROLATOR"
National Air Vibrator Co.
Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.
Viber Co.—"AIRO VIBER," "VIBERLEC," "MODEL PX" "TURBOVIBER"

VIBRATORS, CONVEYOR

Hewitt-Robins Incorporated

VIBRATORS, R.R. HOPPER CAR

Martin Engineering Co.—"VIBRALATOR"

VOLTMETERS, INDICATING

General Electric Co., Apparatus Sales Div.
Martindale Electric Co.
Westinghouse Electric Corp.

VOLTMETERS, RECORDING

The Bristol Co.—"BRISTOL's"
General Electric Co., Apparatus Sales Div.
Westinghouse Electric Corp.

WALLS, SUSPENDED FURNACE

Bigelow-Liptak Corp.

WARNING SIGNALS

American Mine Door Co.
Crouse-Hinds Co.
General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

WARNING SIGNALS, FLASHING

General Equipment & Manufacturing Co.
Nachod & U.S. Signal Co.

WASHABILITY TESTS

The Daniels Co.

WASHABILITY & SCREEN TESTS

Warner Laboratories, Inc.

WASHERS FOR AIR

The Ducon Co., Inc.

WASHERS, CALCIUM-CHLORIDE

Fuel Process Co., Inc.—"BELKNAP"
Kanawha Mfg. Co.

WASHERS, COAL

Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-61—"LINK-BELT," "AIR-PULSATED," "AEROPOISE"
Ore Reclamation Co.—"O.R.C."

WASHERS, COAL SPIRAL

WEMCO Div., Western Machinery Co.—"WEMCO"

WASHERS, HEAVY-MEDIA

The Daniels Co.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Fuel Process Co. (Inc.)—"M-TYPE"
Galis Electric & Machine Co.
Heyl & Patterson, Inc.—"H&P"
Hewitt-Robins Incorporated—"ELIPTEX"
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61—"FLOAT-SINK"
McNally-Pittsburg Mfg. Corp.—"McNALLY TROMP"
The Ore & Chemical Corp.—"OCC VESSEL"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Smith Engineering Works
Southwestern Engineering Co.—"SWECO"
WEMCO Div., Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

WASHERS, JIG

Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp. "McNALLY MOGUL," "McNALLY GIANT," "McNALLY NORTON"
Norton-Tividale, Inc.
Ore Reclamation Co.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Wilmot Engineering Co.

WASHERS, LAUNDERS, TROUGH

The Daniels Co.—"DMS"
Link-Belt Co., Dept. CAMGL-61
K. Prins & Associates—"PRINS"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Wilmot Engineering Co.

WASHERS, JIG, FINE-COAL

Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.

WASHERS, SAND-FLOTATION

Galis Electric & Machine Co.

WASHERS, SCREW

Link-Belt Co., Dept. GAMGL-61

WASHERS, UPWARD-CURRENT

Eagle Iron Works
Fuel Process Co.—"BELKNAP"
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.
Wilmot Engineering Co.

WATER-CLARIFICATION SYSTEMS

The Daniels Co.
Dorr-Oliver, Incorporated
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

WATER NEUTRALIZERS

American Minechem Co.

WATER-RECLAMATION SYSTEMS

Bethlehem Steel Co.
Denver Equipment Co.
Dorr-Oliver, Incorporated
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
K. Prins & Associates
Roberts & Schaefer Company, Division of Thompson-Starrett Company, Inc.

WATER REPELLENTS

American Minechem Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Stonhard Co.—"STONSEAL"
Sike Chemical Corp.—"SIKA-PEL"

WATER SOFTENERS, DEMINERALIZERS

Allis-Chalmers Mfg. Co.
Crane Co.

WATER SYSTEMS, DOMESTIC

Barnes Mfg. Co.

WATER-TREATMENT EQUIPMENT

Allis-Chalmers Mfg. Co.
B-I-F Industries, Inc.
Crane Co.
Shirley Machine Co.

WEARING PLATES

American Manganese Steel Div., American Brake Shoe Co.

WEDGE BARS, TOOTH-REPOINTING, MANGANESE

American Manganese Steel Div., American Brake Shoe Co.
Kensington Steel, Div. of Poor & Co.
Stulz-Sickles Co.—"MANGANAL" "TIGER"

WEDGES, COAL

The Leetonia Tool Co.

WEIGHING EQUIPMENT, ELECTRONIC

Revere Corp. of America

WELDER POWER UNITS

Caterpiller Tractor Co.
Murphy Diesel Co.

WELDERS, ARC

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
Caterpillar Tractor Co.
Flood City Brass & Electric Co.
Harnischfeger Corp.
Hobart Bros. Co.
The Lincoln Electric Co.—"SHIELD-ARC," "IDEAL-ARC," "LINCOLNWELD," "LINCWELDER," "INNER-SHIELD," "SQUIRT WELDER"
Metal & Thermit Corp.—"M & T"
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

WELDERS, AUTOMATIC

Hobart Bros. Co.
Stoody Co.

WELDERS, RAIL-BONDING

Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"GUYAN"
Ohio Brass Co.
Penn Machine Co.
The Post Glover Electric Co.—"P-G"

WELDERS, RECTIFIER

Harnischfeger Corp.

WELDERS, SEMI-AUTOMATIC

Alloy Rods Co.—"WEAR-O-MATIC WIRE FEED"
Hobart Bros. Co.

WELDERS, TRANSFORMER

Harnischfeger Corp.
Hobart Bros. Co.
The Lincoln Electric Co.—"IDEALARC," "LINC-WELDER"
Westinghouse Electric Corp.

WELDING CABLE

Collyer Insulated Wire Co.
Cornish Wire Co., Inc., Div. of General Cable Corp.
Gar Wood Industries, Inc.
General Cable Corp.
General Electric Co., Wire and Cable Dept.
Hobart Bros. Co.
Kaiser Aluminum & Chemical Sales, Inc.—"KAISER MASTERGOLD
The Lincoln Electric Co.—"STABLE-ARC," "LINCOLN-DUCTOR"
National Electric Div., H. K. Porter Co., Inc.
Reynolds Metals Co.
Rome Cable, Div. of Alcoa—"ROME 60"
Tweco Products, Inc.—"TWECO LITE

WELDING, CUTTING TORCHES, OUTFITS

The Arcair Co.
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
General Scientific Equipment Co.—"GS"

WELDING-ELECTRODE HOLDERS

Air Reduction Sales Co. A Div. of Air Reduction Co., Inc.
Erico Products, Inc.—"CADDY"
Hobart Bros. Co.
The Lincoln Electric Co.—"COOL-TON," "INS," "HT," "T"
Mosebach Electric & Supply Co.
Tweco Products, Inc.—"TWECO-TONG"

WELDING ELECTRODES

Alloy Rods Co.—"ATOM ARC," "ARCALOY," "TOOL ARC," "NICKEL ARC," "BRONZE ARC"
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Ampco Metal, Inc.—"AMPCO-TRODE," "PHOS-TRODE," "AMPCO-BRAZ" "SIL-TRODE" "AMPCO-WELD"
Eutectic Welding Alloys Corp.
Flood City Brass & Electric Co.
Harnischfeger Corp.
Hobart Bros. Co.
The Lincoln Electric Co.—"JET-WELD," "FLEETWELD," "SHIELD-ARC," "STAIN-WELD," "ALUMINUM-WELD," "AERISWELD," "FERRO WELD," "PLANE-WELD," "SOFTWELD"
The McKay Co.—"McKAY HARD-ALLOY"
Metal & Thermit Corp.—"MUREX"
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Stoody Co. (Stainless)
Stulz-Sickles Co.—"MAN-GANAL," "SOLID SEMI-AUTOMATIC COIL MAN-GANAL," "STULZ MANGAN-ESE-XL," "STULZ PIERCING ELECTRODES"
Taylor-Wharton Co., Div., Harsco Corp.—"TIMANG"
Wall Colmonoy Corp.—"HARD-SURFACING," "COLMONOY"
Westinghouse Electric Corp.

WELDING ELECTRODES, CARBON, GRAPHITE

The Arcair Co.
Helwig Carbon Products, Inc.
Hobart Bros. Co.

The Lincoln Electric Co.—"E 231" "E 882"
National Carbon Co., Div. of Union Carbide Corp.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Stackpole Carbon Co.

WELDING ELECTRODES, NICKEL, NICKEL ALLOY

Huntington Alloy Products Div., International Nickel Co., Inc.

WELDING EQUIPMENT, INERT GAS ARC

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.—"AIROMATIC," "HELI-"WELD," "AIRCOSPOT"

WELDING-FLUX RECLAMATION SCREENS

Simplicity Engineering Co.

WELDING FLUXES

Eutectic Welding Alloys Corp.
The Lincoln Electric Co.—"LINCOLNWELD 760, 780, 781, 840"
Rexarc, Inc.—"REXARC"

WELDING FUME EXHAUSTERS

The Arcair Co.

WELDING GASES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.—(oxygen, acetylene)

WELDING GOGGLES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
American Optical Co., Safety Products Div.—"DURAWELD"
Bausch & Lomb Inc.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Hobart Bros. Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Safety Service Co.

WELDING GROUND CLAMPS

Albert & J. M. Anderson Mfg. Co.
Erico Products, Inc.—"CADDY"
Flood City Brass & Electric Co.
Hobart Bros. Co.
The Lincoln Electric Co.—"GC 300P" "GC 500"
Ohio Brass Co.—"KLIPLOK"
Trico Fuse Mfg. Co.
Tweco Products, Inc.—"TWECO"

WELDING HELMETS

American Optical Co., Safety Products Div.—"WELD COOL"
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Hobart Bros. Co.
The Lincoln Electric Co.—"COOLSHIELD"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

WELDING HOLDERS

Flood City Brass & Electric Co.
Hobart Bros. Co.

WELDING HOSE

Carlyle Rubber Co., Inc.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated—"TWIN-WELD"
Raybestos Manhattan Inc., Manhattan Rubber Div.
Thermoid Div., H. K. Porter Co., Inc.

WELDING PLUGS, ELECTRICAL

Joy Mfg. Co.
Tweco Products, Inc.

WELDING POSITIONERS

Harnischfeger Corp.
Rexarc, Inc.—"REXARC"

WELDING RECTIFIERS

Hobart Bros. Co.

WELDING RODS, WIRE

General Electric Co., Wire & Cable Dept.

WELDING SHIELDS

American Optical Co., Safety Products Div.
Flood City Brass & Electric Co.
General Scientific Equipment Co.—"GS"
Hobart Bros. Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

WELDING SURFACE PROTECTION COMPOUNDS

Arcair Co.

WELDING-TUBE FITTINGS

Parker Fittings & Hose Div., Parker-Hannifin Corp.—"WELD-LOK"

WELDING WIRE

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
The McKay Co.—"McKAY TUBE-ALLOY" (automatic and semi-automatic)
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Rexarc, Inc.—"REXARC"
Stoody Co. (stainless)

WELDMENTS

American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
onnellsville Corp.
The Falk Corp.
Koven Fabricators, Inc.
Meckum Engineering, Inc.
Phoenix Steel Corp., Structural & Tube Divs.
Sanford-Day Corp.

WELDMENTS, CAST

ESCO Corp.

WETTING AGENTS

American Cyanamid Co., Explosives and Mining Chemicals Depts.—"AEROSOL®"
American Minechem Co.
Hodag Chemical Corp.

WHEEL ASSEMBLIES, PACKAGED

ACF Industries
Irwin-Sensenich Corp.

WHEELBARROWS

The Wood Shovel & Tool Co.

WHEELBARROWS, POWERED
Prime Mower Co.—"15B"

WHEEL EXCAVATORS
Bucyrus-Erie Co.
Link-Belt Co., Dept. CAMGL-61 "LMG,"

WHEELS, CAR
American Brake Shoe Co., Railroad Products Div.

WHEELS, FABRICATED HARDFACED
Sanford-Day Corp.

WHEELS, LOCOMOTIVE, CAST-IRON
American Car & Foundry Div., ACF Industries, Inc.
The Ironton Engine Co.—"IRONTON"
Irwin Sensenich Corp.

WHEELS, LOCOMOTIVE, STEEL
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
Farrell-Cheek Steel Co.
The Ironton Engine Co.—"IRONTON"
Pittsburgh Gear Co.
Sterling Steel Casting Co.

WHEELS, LOCOMOTIVE, STEEL, REBUILT
Leman Machine Co.

WHEELS, MACHINE-TRUCK
Irwin Sensenich Corp.
Enterprise Wheel & Car Corp.
United States Rubber Co.

WHEELS, MINE-CAR
Farrell-Cheek Steel Co.
Link-Belt Co., Dept. CAMGL-61

WHEELS, MINE-CAR, CAST-IRON
American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works "GEMCO TRU-BLU"
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin-Sensenich Corp.
Link Belt Co., Dept. CAMGL-61
McLanahan Corp.
Sanford Day Corp.
Watt Car & Wheel Co.

WHEELS, MINE-CAR, MANGANESE
Kensington Steel, Div. of Poor & Co.

WHEELS, MINE-CAR, STEEL
American Manganese Steel Div., American Brake Shoe Co.—"AMSCO"
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Farrell-Cheek Steel Co.
Gibralter Equipment & Mfg. Co. —"GEMCO TRU-BLU"
Irwin-Sensenich Corp.
National Castings Co.—"NACO"
Sanford-Day Corp.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

WINCHES
Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Clyde Iron Works, Inc.
Cowanesque Valley Iron Works
Gar Wood Industries, Inc.
Hewitt-Robins Incorporated
Ledeen Mfg. Co.
Link-Belt Co., Dept. CAMGL-61
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Tulsa Products Div. Vickers, Inc. —"TULSA"

WINCHES, AIR
Joy Mfg. Co.

WINCHES, PIPE-DRIVING
Sprague & Henwood, Inc.

WIRE
Republic Steel—"REPUBLIC"

WIRE, ARMATURE-BANDING, STAINLESS, CARBON-STEEL
Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, ELECTRICAL—See Also Cable

WIRE, ELECTRICAL, BARE

American Steel & Wire Div., U. S. Steel Corp.—"TIGER BRAND"
Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
General Cable Corp.
The Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co. (Aluminum)
Rome Cable, Div. of Alcoa

WIRE, ELECTRICAL, INSULATED

American Steel & Wire Div., U.S. Steel Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD" "ALUMOWELD"
Cornish Wire Co., Inc., Div. of General Cable Corp.
Ensign Electric & Mfg. Co.
General Cable Corp.
General Electric Co., Wire and Cable Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales Inc.
National Electric Div., H. K. Porter Co., Inc.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.
Rockbestos Wire & Cable Co., Div. of Cerro Corp.
Rome Cable, Div. of Alcoa
Simplex Wire & Cable Co.

WIRE, FEEDER

Aluminum Company of America
American Steel & Wire Div., U.S. Steel Corp.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
General Cable Corp.
General Electric Co., Wire & Cable Dept.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
Phelps Dodge Copper Products Co.
Rome Cable, Div. of Alcoa

WIRE, MAGNET

General Electric Co., Wire & Cable Dept.

WIRE, SHAPED

Bethlehem Steel Co.
Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, SHOTFIRING—See also "Cable, Shotfiring"

American Steel & Wire Div., U.S. Steel Corp.
Circle Wire & Cable Corp.
Cornish Wire Co., Inc., Div. of General Cable Corp.
General Cable Corp.
General Electric Co., Wire and Cable Dept.
Kaiser Aluminum & Chemical Sales, Inc.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div.
Phelps Dodge Copper Products Co.
Rome Cable, Div. of Alcoa
Trojan Powder Co.

WIRE, TELEPHONE

American Steel & Wire Div., U.S. Steel Corp.—"AMER-TEL"
Bethlehem Steel Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
National Electric Div. H. K. Porter Co., Inc.
Okonite Co.
Page Steel & Wire Div., American Chain & Cable Co., Inc.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.

WIRE, THERMOCOUPLE

West Instrument Corp.

WIRE, TROLLEY

American Steel & Wire Div., U.S. Steel Corp.
Anaconda Wire & Cable Co.
General Cable Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
The Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.

WIRE & WIRE PRODUCTS

Jones & Laughlin Steel Corp.

WIRE CLOTH

Hewitt-Robins Incorporated—"GYRALOG," "SUPER GYRALOY"
Hoyt Wire Cloth Co.—"SUPER-TOUGH," "ABRASO," "SUPERHARD STAINLESS STEEL," "SMOOTH TOP," "LONG-SLOT," "OBLONG," "DOUBLE CRIMP"
Ludlow Saylor Wire Cloth Co.
W. S. Tyler Co.

WIRE ENAMELS

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Dept.—"ALKANEX®"

WIRE ROPE

American Chain & Cable—"LAY-SET," "TRU-LAY," "VHS"
American Steel & Wire Div., U.S. Steel Corp.—"TIGER BRAND"
Bergen Wire Rope Co.
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND" "POWERSTEEL"
The Colorado Fuel & Iron Corp., "WICKWIRE" "DOUBLE GRAY-X"
Flood City Brass & Electric Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"HERCULES RED STRAND," "PORTER IMPERIAL RED STRAND"
LeTourneau-Westinghouse Co.—"TOURNAROPE"
Macwhyte Wire Rope Co.—"WHYTE STRAND," "MAC-WHYTE," "MONARCH" "PREMIUM" "HI-LASTIC" "HI-FATIGUE" "7-FLEX" "HI-FLEX"
National Mine Service Co.
Kurt Orban Co., Inc., Industrial Equipment Div.
Rochester Ropes, Inc.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
W. J. Savage Co.
Union Wire Rope, Armco Steel Corp.—"TUFFY"
The Upson-Walton Co.
West Virginia Armature Co.
Wire Rope Corp. of America, Inc. —"WIRECO" "BROWN STRAND"

WIRE ROPE BOOM PENDANTS

Bethlehem Steel Co.
Union Wire Rope, Armco Steel Corp.

WIRE-ROPE CLAMPS

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Jones & Laughlin Steel Corp.—"JALKAMPS," "JALLOC"
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
Union Wire Rope, Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE CLIPS

American Chain & Cable—"ACCO CLIPS"
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.—"ALTCO"
Broderick & Bascom Rope Co.—"YELLOW STRAND"
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY"
Ensign Electric & Mfg. Co.
Farrell-Cheek Steel Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Union Wire Rope, Armco Steel Corp.
The Upson-Walton Co.—"GOLD CLIP"
Wire Rope Corp. of America, Inc. —"WIRECO"

WIRE-ROPE EYES

American Chain & Cable
Jones & Laughlin Steel Corp.
Joy Mfg. Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.

WIRE-ROPE FITTINGS

American Steel & Wire Div., U.S. Steel Corp.
Farrell-Cheek Steel Co.
Rochester Ropes, Inc.
Wire Rope Corp. of America, Inc. —"WIRECO"

WIRE-ROPE LUBRICANTS

Ashland Oil & Refining Co.—"VALVOLINE-ASHLAND"
Cities Service Oil Co.
Esso Standard, Div. of Humble Oil and Refining Co.—"SURETT," "SURRETT FLUIDS," "COBLAX"
Hulburt Oil & Grease Co.—"HULBURT BLACKBERRY SPRAY, GEAR AND CABLE SHIELD"
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Wire Rope Co.
Mobile Oil Co., A Div. of Socony Mobil Oil Co., Inc.
New York & New Jersey Lubricant Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Shell Oil Co.
Texaco Inc.
The Whitmore Mfg. Co.

WIRE-ROPE SHACKLES

American Chain & Cable
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
ESCO Corp.
Farrell-Cheek Steel Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Union Wire Rope, Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE SLINGS

Bethlehem Steel Co.
Rochester Ropes, Inc.

WIRE-ROPE SOCKETS

American Chain & Cable
The Bowdil Co.
Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
ESCO Corp.
Farrell-Cheek Steel Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
Sauerman Bros., Inc.
Union Wire Rope, Armco Steel Corp.
The Upson-Walton Co.

WIRE-ROPE SWAGED ASSEMBLIES

American Chain & Cable—"TRU-LOC"
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"BROLOC"
ESCO Corp.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
W. J. Savage Co.
Union Wire Rope, Armco Steel Corp.
Wire Rope Corp. of America, Inc. —"WIRECO"

WIRE-ROPE SWIVELS

Crosby-Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Jones & Laughlin Steel Corp.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
The Upson-Walton Co.

WIRE-ROPE THIMBLES

Crosby-Laughlin Div. American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Farrell-Cheek Steel Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Macwhyte Wire Rope Co.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp.
The Upson-Walton Co.
Union Wire Rope, Armco Steel Corp.

WIRE-ROPE, CONDUCTOR-CORE

American Chain & Cable—"SIG-NALKORE"

WIRE ROPE, PLASTIC COATED

Rochester Ropes, Inc.

WIRE ROPE, STAINLESS-STEEL, CORROSION-RESISTING, MONEL-METAL, PLATIC-COATED AND NYLON-COATED

Macwhyte Wire Rope Co.

WIRE ROPE, SWING TAIL, CAR-PULLER

The Upson-Walton Co.

WIRE STRAND

Page Steel & Wire Div. American Chain & Cable Co., Inc.—(7-wire galvanized, "ACCO" aluminized)

WIRE STRIPPERS

Martindale Electric Co.

WIRING DEVICES

Arrow Hart & Hegeman Electric Co.
The Elreco Corp.
Holub Industries, Inc.
National Electric Div. H. K. Porter Co., Inc.

WIRING SYSTEMS, UNDER FLOOR

General Electric Co., Conduit Products Dept.

WOOD PRESERVATIVES

Darworth, Inc., Chemical Products Div.—"CUPRINOL"
The Dow Chemical Co.
E. I. du Pont de Nemours & Co., Inc. ("CZC" Chromated Zinc Chloride)
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS," "OSMO-PLASTIC," "M-T-M"
The Wilbur & Williams Co. Inc. —"PERMODIP"

WRENCHES, BIT

Duquesne Mine Supply Co.
Joy Mfg. Co.
The Leetonia Tool Co.
North American Gear Co. (reversible ratchet)
Frank Prox Company Inc.
Bertrand P. Tracy Co.

WRENCHES, HOPPER

Advance Car Mover Co., Inc.—"ADVANCE SAFETY"

WRENCHES, IMPACT

The Black & Decker Mfg. Co.—(Portable electric)
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Penn Machine Co.
Remington Arms Co., Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.—"SNAP-ON"
Thor Power Tool Co.

WRENCHES, SET SCREW

The Leetonia Tool Co.

WRENCHES, TORQUE

Bearings, Inc.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Proto Tool Co., Div. of Pendleton Tool Industries, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.—"SNAP-ON"

WRENCHES, TRACK

Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.

WROUGHT-IRON BARS, SHAPES, TUBING

A. M. Byers Co.

YO-YOS, ELECTRIC

The Nolan Co.

YO-YOS, HYDRAULIC

The Nolan Co.
Schroeder Brothers Corp.
W. R. Stamler Corp.

YO-YOS, HYDRAULIC, REBUILT

Leman Machine Co.

The Coal Age Mining Guidebook . . .

Directory of Manufacturers

BLACK-FACED TYPE indicates a product-information advertisement in this issue. Page number or numbers are given following the address in each instance.

A

ABC Scale Div., McDowell Co., Inc., 16300 Waterloo Rd., Cleveland 10, Ohio
Acker Drill Co. Inc., P.O. Box 830, Scranton, Pa.
Acme Chain Corp., 821 Main St., Holyoke, Mass.
Acme Electric Corp., 2009 Water St., Cuba, N.Y.
Acme-Hamilton Mfg. Corp., Meade St., Trenton, N. J., ADV. p347
Acme Machinery Co., Box 2409, Huntingdon, W. Va.
Advance Car Mover Co., Inc., Box 536, Appleton, Wis.
Aerial Surveys, Inc., 4614 Prospect Ave., Cleveland, Ohio
Aero Service Corp., 210 East Courtland St., Philadelphia 20, Pa.
Aeroquip Corp., 300 S. East Ave., Jackson, Mich., ADV. p307
A G A Corp. of America, P.O. Box 447—2013 Park Ave., South Plainfield, N. J.
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc., 150 East 42nd St., New York 17, N. Y.
Airmite-Midwest, Inc., 119 North Chestnut St., DuQuoin, Ill.
Ajax Flexible Coupling Co. Inc., 17 English St., Westfield, N. Y.
The Aldon Co., 3338 Ravenswood Ave., Chicago 13, Ill.
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Allegheny Ludlum Steel Corp., Carmet Div., 1500 Jarvis Ave., Detroit 20, Mich., ADV. p25
Allen & Garcia Co., 322 South Michigan Ave., Chicago 4, Ill.
The Allen-Sherman-Hoff Pump Co., P. O. Box 635, Paoli, Pa.
Allentown Pneumatic Gun Co., 1520 Walnut St., Allentown, Pa.
Allied Chemical Corp., Nitrogen Div., 40 Rector St., New York 6, N. Y.
Allied Chemical Corp., Solvay Process Div., 61 Broadway, New York 6, N. Y.
Allis-Chalmers Mfg. Co., 986 South 70 St., Milwaukee 1, Wis., ADV. p55
The Louis Allis Co., 427 E. Stewart St., Dept. P, Milwaukee 1, Wis.
Allison-Campbell Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.
Allison Div., General Motors Corp., 4700 W. 10th St., Indianapolis, Ind., ADV p151
Alloy Rods Co., York, Pa.
Aluminum Company of America, 2501 Alcoa Bldg., Mellon Sq., Pittsburgh 19, Pa.
Amercoat Corp., 4809 Firestone Blvd., South Gate, Calif.
American Air Filter Co., Inc., 267 Central Ave., Louisville 8, Ky.
American Air Surveys, Inc., 907 Penn Ave., Pittsburgh 22, Pa.
American Alloy Corp., 3885 E. 78th St., Cleveland 5, Ohio
American Brake Shoe Co., American Brakeblok Div., P. O. Box 21, Birmingham, Mich.
American Brake Shoe Co., National Bearing Div., 717 Grant Bldg., Pittsburgh 19, Pa.
American Brake Shoe Co., Railroad Products Div., 530 Fifth Ave., New York 36, N. Y.
American Brattice Cloth Corp., 200 Kings Highway, Warsaw, Ind., ADV. p322
American Bridge Div., U. S. Steel Corp., 204 Frick Bldg., Pittsburgh 30, Pa.
American Car & Foundry Div., ACF Industries, Inc., 730 Third Ave., New York 17, N. Y.
American Chain & Cable, Wilkes Barre, Pa.
American Chain Div., American Chain & Cable Co., Inc., E. Princess & Charles Sts., York, Pa., ADV. p31
American Conveyor Co., 2133-37 S. Christiana Ave., Chicago 23, Ill.
American Crucible Products Co., 1305 Oberlin Rd., Lorain, Ohio
American Cyanamid Co., Explosives and Mining Chemicals Dept., Bound Brook, N. J., ADV. p291
A E Industrial Div., Aircraft Armaments, Inc., P. O. Box 6853, Baltimore 4, Md.
American Hoist & Derrick Co., 63 South Robert St., St. Paul 7, Minn.
American LaFrance, Div. of Sterling Precision Corp., 100 East LaFrance St., Elmira, N. Y.
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
American Manganese Steel Div., American Brake Shoe Co., Chicago Heights, Ill., ADV. p6
American MARC Inc., 1601 West Florence Ave., P. O. Box 549, Inglewood, Calif.
American Mine Door Co., 2057 Dueber Ave., S. W., Canton 6, Ohio, ADV. p336
American Mine Supply Co., 404 Frick Bldg., Pittsburgh 19, Pa.
American Minechem Co., P. O. Box 231, Coraopolis, Pa.
The American Oil Co., 910 So. Michigan Ave., Chicago 80, Ill.
American Optical Co., Safety Products Div., 90 Mechanic St., Southbridge, Mass.
American Paulin System, 1524 South Flower St., Los Angeles 15, Calif.
The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo.
American - Standard Industrial Div., Detroit 32, Mich.
American Steel Foundries, 3761 Canal St., East Chicago, Ind.
American Steel & Wire Div., United States Steel Corp., Rockefeller Bldg., Cleveland 13, Ohio, ADV. p38-39
Jack Ammann, Inc., Engineers & Surveyors, 931 Broadway, San Antonio 5, Texas
Ampco Metal, Inc., 1723 South 38 St., Milwaukee 1, Wis.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y., ADV. p125, 142
Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Coupling Co., Inc., 342 No. Fourth St., Libertyville, Ill.
Anchor Packing Co., 401 North Broad St., Philadelphia 8, Pa.
Albert & J. M. Anderson Mfg. Co., 289 A St., Boston 10, Mass.
The Ansonia Wire & Cable Co., 111 Martin St., Ashton, R. I.
Ansul Chemical Co., Marinette, Wis.
The Arcair Co., P. O. Box 431, Lancaster, Ohio
Armco Drainage & Metal Products, Inc., 6770 Curtis St., Middletown, Ohio
Armstrong, Bray & Co., 5364 Northwest Hwy., Chicago 30, Ill.
Aro Equipment Corp., Bryan, Ohio
Arrow Hart & Hegeman Electric Co., 103 Hawthorn St., Hartford 6, Conn.
Ashland Oil & Refining Co., Ashland, Ky.
The Atlantic Refining Co., 260 S. Broad St., Philadelphia 1, Pa.
Athey Products Corp., 5631 W. 65 St., Chicago 38, Ill.
Atkinson Armature Works, 116 E. 1st St., Pittsburg, Kan.
Atlas Powder Co., Wilmington 99, Del., ADV p282-283
Auburn Foundry, Inc., Heating Div., Auburn, Ind.
Aurora Pump Div., The New York Air Brake Co., 619 Loucks St., Aurora, Ill.
Austin Powder Co., Rockefeller Bldg., Cleveland 13, Ohio, ADV. p298
Austin - Western, Construction Equipment Div., Baldwin-Lima-Hamilton Corp., 601 N. Farnsworth Ave., Aurora, Ill.
Autocar Div., The White Motor Co., Exton, Pa.
Automatic Vulcanizers Corp., 16 Hudson St., New York 13, N.Y.
Automation Products, Inc., 3030 Max Roy St., Houston 24, Texas
Axeman-Anderson Co., 233 West St., Williamsport 3, Pa.

B

Baldwin-Lima-Hamilton Corp., Construction Equipment Div., South Main St., Lima, Ohio. ADV. p87
Baltimore & Ohio R.R., Baltimore 1, Ohio
Bando Rubber Mfg. Co., Ltd., 1.2-Chone, Meiwa-dori, Hyogoku, Kobe, Japan
Bantam Bearings Div., Torrington Co., 3702 West Sample St., South Bend 21, Ind.
Barber-Greene Co., 400 N. Highland Ave., Aurora, Ill. ADV. p 18-19
Barksdale Valves, 5125 Alcoa Ave., Los Angeles 58, Calif.
Barnes Mfg. Co., 615 N. Main St., Mansfield, Ohio
Barrett, Haentjens & Co., Hazleton, Pa.
Baton & Co., Geo. S., 1100 Union Trust Bldg., Pittsburgh 19, Pa.
Baughman Mfg. Co., Inc., Shipman Rd., Jerseyville, Ill.
Bausch & Lomb, Inc. 8046 Bausch St., Rochester 2, N. Y.
Bearing Service Co., 4650-52 Baum Blvd., Pittsburgh 13, Pa.
Bearings, Inc., 3634 Euclid Ave., Cleveland, Ohio
Bemis Bro. Bag Co., 408 Pine St., Dept. B, St. Louis 2, Mo.
Bergen Wire Rope Co., 151 Gregg St., Lodi, N. J.
C. L. Berger & Sons, Inc., 37 Williams St., Boston 19, Mass.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Steel Co., 701 East Third St., Bethlehem, Pa., ADV. p127-168
B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I.
Bigelow-Liptak Corp., 13300 Puritan Ave., Detroit 27, Mich.
The Bin-Dicator Co., 13946-32 Kercheval Ave., Detroit 15, Mich.
Bird Machine Co., South Walpole, Mass., ADV. p4
Bituminous Casulty Corp., Bituminous Bldg., 320 18th St., Rock Island, Ill.
Bixby-Zimmer Engineering Co., 961 Abington St., Galesburg, Ill. ADV. p62
The Black & Decker Mfg. Co., Towson 4, Md.
Black Diamond Spad Co., 3108 Stratford Rd., Richmond 25, Va.
Blackhawk Industrial Div., N57 W. 13264 Reichert Ave., Butler, Wis.
Blaw-Knox Co., Blaw-Knox Equipment Div., Pittsburgh 38, Pa.
Boston Woven Hose & Rubber Div. American Biltrite Rubber Co., P. O. Box 1071, Boston 3, Mass., ADV. p49
The Bowdil Co., Boylan Ave., S.E., Canton, Ohio. ADV. p14-15
The Branford Co., 132 Glen St., New Britain, Conn.
The Bristol Co., P.O. Box 1790 CA, Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo., ADV. p313
The Brooks Oil Co., 3304 East 87th St., Cleveland 27, Ohio
Brookville Locomotive Works, Steele Blvd., Brookville, Pa.
Browning Mfg. Co., Maysville, Ky.
Charles Bruning Co., Inc., Mount Prospect, Ill.
Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.
Brunner & Lay-Eastern, Inc., 2514-16 E. Cumberland St., Philadelphia 25, Pa.
Bucyrus-Erie Co., South Milwaukee, Wis., ADV. p121
Buell Engineering Co., Inc., 123 William St., New York 38, N.Y. ADV. p148
Buffalo Forge Co., 490 Broadway, Buffalo 5, N.Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N.Y.
Buffalo-Springfield Co., Div. of Koehring Co., 1210 Kenton St., Springfield, Ohio
E. D. Bullard Co., 2680 Bridgeway, Sausalito, Calif.
Burndy Corp., Richards Ave., Norwalk, Conn.
Bussmann Mfg. Div., McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.
Buttner Works, Inc., 52 Vanderbilt Ave., New York 17, N.Y.

A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp., P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

C

C & D Batteries, Div. The Electric Autolite Co., Conshohocken, Pa.
Cable Vulcanizing Shop, Inc., P. O. Box 126, Pecks Mill, W. Va.
Samuel Cabot Inc., 246 Summer St., Boston 10, Mass.
E. K. Campbell Co., 1809 Manchester Ave., Kansas City 26, Mo.
Canton Stoker Corp., 109 Andrew Place, S. W. Canton 1, Ohio
C. S. Card Iron Works, P.O. Box 117, Denver 1, Colo.
Philip Carey Mfg. Co., Cincinnati 15, Ohio
Carlon Products Corp., Box 133, Aurora, Ohio
Carlyle Rubber Co., Inc., 103-107 Warren St., New York 7, N.Y.
Carpenter Heating & Air Conditioning Co., 2135 St. Clair Ave., Cleveland, Ohio
Carrier Div., Chain Belt Co., 211 N. Jackson St., Louisville 2, Ky., ADV. p59
Carver Pump Co., Muscatine, Iowa
J. I. Case Co., 700 State St., Racine, Wis.
A. W. Cash Co., P.O. Box 551, Decatur, Ill.
A. W. Cash Valve Mfg. Corp., 666 E. Wabash, Decatur, Ill.
Caterpillar Tractor Co., Peoria, Ill., ADV. p44-45, 77, 298, 343
Central Mine Equipment Co., 6200 N. Broadway, St. Louis 15, Mo.
Central Mine Supply Co., Div. Pickard Industries, Inc., Mt. Vernon, Ill.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18, Mo. ADV. p339
Chain Belt Co., 4786 W. Greenfield Ave., Milwaukee 1, Wis. ADV. p59
Chain Belt Co., Shafer Bearing Div., P.O. Box 57, Downers Grove, Ill.
Champ Industries Inc., P. O. Box 6781, Philadelphia 32, Pa.
Chase Bag Co., 355 Lexington Ave., New York 17, N.Y.
Cheatham Elec. Switching Device Co., 4780 Crittenden Dr., Louisville 9, Ky., ADV. p332
Chevrolet Motor Div., General Motors Bldg., Detroit 2, Mich.
Chicago Eye Shield Co., 2727 W. Roscoe St., Chicago 18, Ill.
Chicago Perforating Co., 2445 West 24 Pl., Chicago 8, Ill.
Chicago Pneumatic Tool Co., 6 East 33 St., New York, N.Y.; Reichdrill Div., Howard & Orchard St., Franklin, Pa. ADV. p149
Chiksan Co., 330 N. Brea Blvd., Brea, Calif.
J. D. Christian Engineers, 480 Potrero Ave., San Francisco 10, Calif.
Cincinnati Mine Machinery Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio
Cincinnati Rubber Mfg. Co., Div., of Thor Power Tool Co., Franklin Ave., Cincinnati 12, Ohio
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth 78, N.Y., ADV. p164-165
Cities Service Oil Co., 60 Wall Tower, New York 5, N.Y.
Clarage Fan Co., 1 Clarage Pl., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland 10, Ohio
Clark Equipment Co., Construction Machinery Div., P.O. Box 599, Benton Harbor, Mich.
Clark Equipment Co., Automotive Div., Buchanan, Mich.
Clayton Manufacturing Co., P.O. Box 550, El Monte, Calif.
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland, Ohio
Cleveland Wire Cloth & Mfg. Co., 3573 E. 78th St., Cleveland 5, Ohio
Cleveland Worm & Gear Div., Eaton Mfg. Co., 3300 East 80 St., Cleveland 4, Ohio
Clyde Iron Works, Inc., Duluth, Minn.
Coast Metals, Inc., 201 Redneck Ave., Little Ferry, N.J.
Cobra Metal Hose, Div. DK Mfg. Co., 5059 S. Kedzie Ave., Chicago 32, Ill.
Coffing Hoist Div., Duff-Norton Co., P.O. Box 1719, Charlotte 1, N.C.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R.I.
The Colorado Fuel and Iron Corp., Continental Oil Bldg., Denver, Colo.; Wickwire Spencer Steel Div., 575 Madison Ave., New York 22, N.Y., p131
Columbia - Southern Chemical Corp., One Gateway Center, Pittsburgh 22, Pa.
Columbus McKinnon Corp., Mining Equipment Div., Tonawanda, N.Y., ADV. p331
Combustion Engineering, Inc., 200 Madison Ave., New York 16, N.Y.
Combustion Engineering, Inc., Raymond Div., 1132 W. Blackhawk St., Chicago 22, Ill.
The Commercial Shearing & Stamping Co., 1775 Logan Ave., P.O. Box 239, Youngstown 1, Ohio
Commercial Testing & Engineering Co., Suite 924, 228 North La Salle St., Chicago 1, Ill.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
Cone-Drive Gears Div. of Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Connellsville Corp., Box 677, Connellsville, Pa. ADV. p135
R. Conrader Co., Inc., 236 West 17th St., P.O. Box 924, Erie, Pa.
Continental Conveyor & Equipment Co., Winfield, Ala.
Continental Rubber Works, 1933 Liberty St., Erie 6, Pa.
Convair, P.O. Box 9671, Pittsburgh 26, Pa.
Conveyor Belt Service, Inc., Cleveland, Ohio; Virginia, Minn.
Cooke-Wilson Electric Supply Co., 1787 North Highland, Pittsburgh 8, Pa.
Copperweld Steel Co., Wire & Cable Div., Glassport, Pa.
Coppus Engineering Corp., 344 Park Ave., Worcester 10, Mass.
Corhart Refractories Co., Sub. of Corning Glass Works, 940 Commonwealth Bldg., Louisville 2, Ky.
Cornish Wire Co., Div. of General Cable Corp., 50 Church St., New York 7, N.Y.
Cowanesque Valley Iron Works, 960 Elm St., Cowanesque, Pa.
Cowin & Co., Inc., 1 18th St., SW, Birmingham, Ala.
Crane Co., Plumbing Htg. Air-Cond. Group & Pac. Steel Boiler Div., P.O. Box 780, Johnstown, Pa.; Cyclotherm Div., 157 E 1st St., Oswego; Industrial Products Div., 4100 S. Kedzie Ave., Chicago 32, Ill.—Boilers, heating, etc.
Crescent Fastener Co., 381 Park Ave. So., New York 16, N.Y.
Crosby-Laughlin Div., American Hoist, Fort Wayne 1, Ind.
Cross Perforated Metals Plant, National Standard Co., Carbondale, Pa.
Crouse-Hinds Co., Syracuse 1, N.Y.
Crucible Steel Co. of America, P.O. Box 88, Pittsburgh 30, Pa.
Cummins Engine Co. Inc., Columbus, Ind.
Curtis-Wright Corp., South Bend Div., South Bend 23, Ind.
Cutler-Hammer, Inc., 220 N. 12th St. Milwaukee 1, Wis.
Cutter Bit Service Co., 111 West 8th Ave., P.O. Box 533, Huntington, W. Va.

D

D-A Lubricant Co., Inc., 1331 West 29 St., Indianapolis 23, Ind.
Dallas Engineers, Inc., Coal-O-Matic Div., Main St., Trucksville, Pa.
Daly Ticket & Printing Co., 506-08 Vandalia St., Collinsville, Ill.
The Dana Fan & Blower Corp., Gen Offices—49 Central Ave., Cincinnati 2, Ohio; Plant—2644 Colerain Ave., Cincinnati 14, Ohio
C. R. Daniels Co., Daniels, Md.
The Daniels Co., The Daniels Bldg., Bluefield, W. Va.
Darworth Incorporated, Chemical Products Div., Simsbury, Conn.
Davey Compressor Co., 600 Franklin Ave., Kent, Ohio, ADV. p146
Nelson L. Davis Co., 3922 W. Main St., McHenry, Ill.
Day-Ray Products, Inc., 1133 Missions St., South Pasadena, Calif.
Dayton Automatic Stoker Co., 1910 W. Dorothy Lane, Box 2186, Kettering Branch, Dayton 29, Ohio
Dayton Industrial Products Co., 2001 Janice Ave., Melrose Park, Ill.
Dean Brothers Pumps, Inc., 323 West 10th St., Indianapolis 7, Ind.
The Deister Concentrator Co., Inc., 909 Glasgow Ave., Ft. Wayne 1, Ind., ADV. p54
Deister Machine Co., 1933 E. Wayne St., Ft. Wayne 4, Ind.
DeLaval-Holroyd, Inc., 121 First Ave., Trenton 7, N.J.
Delta-Star Electric Div., H. K. Porter Co., Inc., 2437 Fulton St., Chicago 12, Ill.
The Deming Co., Salem, Ohio
Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio
Denver Equipment Co., P.O. Box 5628, Denver 17, Colo.
Diamond Chain Co., Inc., 402 Kentucky Ave., Indianapolis 7, Ind.
Diamond Crystal Salt Co., St. Clair, Mich.
Diamond Electronics, Div. of Diamond Power Specialty Corp., Lancaster, Ohio
Diamond Iron Works, Div., Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Diamond Tool Research Co., Inc., 380 Second Ave., New York 10, N.Y.
Differential Steel Car Co., Differential Ave., Findlay, Ohio, ADV p42
Dings Magnetic Separator Co., 472 W. Electric Ave., Milwaukee 46, Wis.
Disston Div., H. K. Porter Co., Inc., Porter Bldg., Philadelphia 35, Pa.
Joseph Dixon Crucible Co., Monmouth & Wayne Sts., Jersey City 3, N.J.
Dodge Div., Chrysler Corp., 7900 Jos. Campau, Detroit 31, Mich.
Dodge Mfg. Corp., South Union St. Mishawaka, Ind.
Dominick & Dominick, 14 Wall St., New York 5, N.Y.
Dooley Brothers, 1201 S. Washington St., Peoria, Ill.
Dorr-Oliver Incorporated, 77 Havemeyer Lane, Stamford, Conn., ADV. p10-11
The Dow Chemical Co., Midland, Mich.; Dowell Div., 1918 Highway 40 North, Evansville 7, Ind., ADV. p139
Dow Corning Corp., Midland, Mich.
Dowty Mining Equipment Ltd., Ashchurch, Gloucestershire, England
Dravo Corp., Neville Island, Pittsburgh 25, Pa., ADV. p34-35
Dresser Mfg. Div., Dresser Industries, Inc., 450 Fisher Ave., Bradford, Pa.
The Ducon Co., Inc., 154 E. Second St., Mineola, N.Y.
Duff-Norton Co., P.O. Box 1719, Charlotte 1, N.C.
E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del., ADV. p33, 150, 167
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 North Main St., Elkhart, Ind.
The Duriron Co., Inc., 450 North Findlay St., Dayton 4, Ohio
Dynamatic Div., Eaton Mfg. Co., 3122 Fourteenth Ave., Kenosha, Wis.

E

Eagle Iron Works, 161 Holcomb Ave., Des Moines 4, Iowa.
Eastern Sales Co., Div. of Eastern Co., 4700 Clairton Blvd., Pittsburgh 36, Pa.
Eaton Mfg. Co., Axle Div., 739 East 140th St., Cleveland 10, Ohio
Eavenson, Auchmuty & Greenwald, 2320 Koppers Bldg., Pittsburgh 19, Pa.
Economy Fuse Div., Federal Pacific Electric Co., 2070 Maple St., Des Plaines, Ill.
The Eimco Corp., 630 South 4th West St., Salt Lake City 10, Utah
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N.J.
Electric Machinery Mfg. Co., 800 Central Ave., Minneapolis 13, Minn.
Electric Products Co., 1725 Clarkstone Rd. Cleveland 12, Ohio
The Electrical Distributors Co., Penn Square Building, Philadelphia 7, Pa.
Electro Dynamic Div. of General Dynamics Corp., 163 Avenue A, Bayonne, N.J.
Elliott Co., 900 N. Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 N. MacQuesten Pkwy., Mt. Vernon, N.Y.
The Elreco Corp., 2000 Central Ave., Cincinnati 14, Ohio
The Ensign-Bickford Co., P.O. Box 308, Simsbury, Conn.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington, W. Va.
Enterprise Wheel & Car Corp., Bristol, Va.
Erico Products, Inc., 2070 E. 61 Pl., Cleveland 3, Ohio
Eriez Manufacturing Co., 228 Magnet Drive, Erie, Pa.
Esco Corp., 2141 N. W. 25th Ave., Portland 10, Oregon ADV. p69, 70
Esso Standard, Div. of Humble Oil and Refining Co., 15 West 51 St., New York, N.Y., ADV. p48
Euclid Div., General Motors Corp. Hudson, Ohio ADV. p111
Eutectic Welding Alloys Corp., 40-40 172nd St., Flushing 58, N.Y.
Exide Industrial Marketing Div. The Electric Storage Battery Co., Rising Sun and Adams Aves., Philadelphia 2, Pa., ADV. p152
Extremultus, Inc., 130 Coolidge Ave., Englewood, N.J.

F

Fadlevich Cable Vulcanizing Shop Inc., P.O. Box 106, Rivesville, W. Va.
FWD Corp., E. 12th St., Clintonville, Wis.
The Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
George E. Failing Co., Sub. of Westinghouse Air Brake Co., Enid, Okla.
The Fairbanks Co., 393 Lafayette St., New York 3, N.Y.
Fairbanks Morse & Co., 606 S. Michigan Ave., Chicago 5, Ill. ADV. p166
Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles 15,
Fairview Bit Co., Fairview, W. Va., ADV. p351
The Falk Corp., Box 492, Milwaukee 1, Wis., ADV. p163
Farrel-Birmingham Co., Inc., 344 Vulcan St., Buffalo 7, N.Y.
Farrell-Cheek Steel Co., 106 Lane St., Sandusky, Ohio, ADV. p132
Farris Flexible Valve Corp., 400 Commercial Ave., Palisades Park, N.J.
Farval Div., Eaton Mfg. Co., 3300 East 80th St., Cleveland 4, Ohio
The Federal Bearings Co. Inc., Poughkeepsie, N.Y.
Federal-Mogul Service, Div. Federal-Mogul — Bower Bearings, Inc., 11031 Shoemaker Ave., Detroit 13, Mich., ADV. p53
Femco, Inc., Irwin, Pa.
Filter Fabrics, Inc., 814 E. Jefferson St., Goshen, Ind.
Filtration Engineers Div., American Machine & Metals Inc., East Moline, Ill.
Firestone Tire & Rubber Co., 1200 Firestone Parkway, Akron 17, Ohio, ADV. p279
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.
Fisher Scientific Co., 717 Forbes Ave., Pittsburgh 19, Pa.
J. H. Fletcher & Co., P.O. Box 2143 Huntington 18, W. Va. ADV. p281
Flexaust Co., 100 Park Ave., New York 17, N.Y.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.
Flexo Products, Inc., 24864 Detroit Rd., Westlake, Ohio
Flood City Brass & Electric Co., Messenger & Elder Sts., Johnstown, Pa., ADV. p333
Flygt Corp., Hoosick Falls, N.Y.
Foote Brothers Gear & Machinery Corp., 4545 South Western Blvd., Chicago, Ill.
Foote Mineral Co., 18 W. Chelten Ave., Philadelphia 44, Pa.
Ford Div. of Ford Motor Co., P.O. Box 658, Dearborn, Mich. ADV. p104-105
Foxboro Co., Foxboro, Mass.
Fred's Welding Service, P.O. Box 178, Grundy, Va.
The Frick-Gallagher Mfg. Co., 110 S. Michigan Ave., Wellston, Ohio

Fuel Process Co. Inc., 900 D St., South Charleston 3, W. Va.
Fuel Research & Instrument Co., 626 Broad St., Charleston 23, W. Va.
Fuller Transmission Div., Eaton Mfg. Co., Prouty St. Kalamazoo, Mich., ADV. p329
Fulton Cotton Mills, P.O. Box 1726, Atlanta 1, Ga.
The Fyr-Fyter Co., 221 Crane St., Dayton 1, Ohio

G

GM DIESEL, Detroit Diesel Engine Div., General Motors Corp., 13400 West Outer Drive, Detroit 20, Mich. ADV. p143
GMC Truck & Coach, General Motors Corp., Pontiac, Mich.
G & W Electric Specialty Co., 3500 W. 127 St., Blue Island, Ill.
The Galigher Co., 545-585 West 8th South St., P.O. Box 209, Salt Lake City 10, Utah
Galion Allsteel Body Co., 605 S. Market St., Galion, Ohio
Galion Iron Works & Mfg. Co., Galion, Ohio
Galis Electric & Machine Co., P.O. Box 2027 WO, Morgantown, W. Va. ADV. p56-57
Gardner-Denver Company, Gardner Expressway, Quincy, Ill.
Garlock, Inc., 402 East Main St., Palmyra, N.Y.
Gar Wood Industries, Inc., Wayne, Mich.
The Gates Rubber Co., 999 South Broadway, Denver 17, Colo.
General Cable Corp., 730 Third Ave., New York 17, N.Y.
General Electric Co., Apparatus Sales Div., 1 River Road, Schenectady 5, N.Y.
General Electric Co., Chemical and Metallurgical Div., Insulating Materials Dept., Campbell Rd., Schenectady 6, N.Y.
General Electric Co., Communication Products Dept., Lynchburg, Va.
General Electric Co., Conduit Products Dept., 980 Warren Ave., Niles, Ohio
General Electric Co., Wire and Cable Dept., 1285 Boston Ave., Bridgeport, Conn.
General Electric Co., Lamp Div., Nela Park, Cleveland, Ohio
General Electric Co., Locomotive & Car Equipment Dept., 2901 E. Lake Rd., Erie 1, Pa., ADV. p12
General Equipment & Manufacturing Co., 116 S. Campbell St., Louisville 6, Ky.
General Scientific Equipment Co., Limekiln Pike & Williams Ave., Philadelphia 50, Pa.
General Splice Corp., 32 Woodworth Ave., Yonkers, N.Y.
The General Tire & Rubber Co., 1708 Englewood Ave., Akron, Ohio
Geo Optic & Paper Corp., 149 Church St., New York 7, N.Y.
Gering Plastics, Div. of Studebaker-Packard Corp., North 7th St. and Monroe Ave., Kenilworth, N.J.
Gibraltar Equipment & Mfg. Co., P.O. Box 304, Alton, Ill.
Goodall Rubber Co., Whitehead Rd., Trenton, N.J.
Goodman Mfg. Co., Halsted St. & 48th Place, Chicago 9, Ill., ADV. p51
B. F. Goodrich Aviation Products, 500 South Main St., Akron, Ohio
B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio
B. F. Goodrich Footwear and Flooring Co., a Div. of The B. F. Goodrich Co., Watertown 72, Mass.
B. F. Goodrich Industrial Products Co., 500 South Main St., Akron 18, Ohio, ADV. p1
B. F. Goodrich Tire Co., A Div. of the B. F. Goodrich Co., Akron, Ohio
Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio
The Gorman-Rupp Co., 305 Bowman St., Mansfield, Ohio
Gould - National Batteries, Inc., Trenton 7, N.J.
Goulds Pumps, Inc., 300 Fall St., Seneca Falls, N.Y.
Goyne Pump Co., Ashland, Pa.
Gray Co., Inc., 60 Eleventh Ave., N. E., Minneapolis 13, Minn.
Grinnell Co., 260 West Exchange St., Providence 1, R.I.
Gruendler Crusher & Pulverizer Co., 2917 No. Market St., St. Louis 6, Mo. ADV. p303
Gulf Oil Corp., Dept. DM, P.O. Box 2140, Houston 1, Tex. ADV. p20-21
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc., P.O. Box 283, Belleville, Ill., ADV. p64
Gurley, W. & L. E., 1904 Fifth Ave., Troy, N.Y.
Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.
Guyan Machy. Co., 755 Stratton, Logan, W. Va.

H

H & L Tooth Co., 1540 South Greenwood Ave., Montebello, Calif., ADV. p345
Hagan Chemicals & Controls, Inc., P.O. Box 1346, Pittsburgh 30, Pa.
Hammermills, Inc., 625 C. Ave., N. W., Cedar Rapids, Iowa
J. V. Hammond Co., Sprangle, Pa.
F. R. Hannon & Sons, Canton 7, Ohio
Hardinge Co., Inc., 240 Arch St., York, Pa.
Harnischfeger Corp., 4444 W. National Ave., Milwaukee 46, Wis., ADV. 2nd Cover
The Harrington & King Perforating Co., Inc., 5655 W. Fillmore St., Chicago 44, Ill.
Brad Harrison Co., 4222 Warren Ave., Hillside, Ill.
Hauck Mfg. Co., 144-154 Tenth St., Brooklyn 15, N.Y.
The Hauser-Stander Tank Co., 4838 Spring Grove Ave., Cincinnati 32, Ohio, ADV. p324
Herb J. Hawthorne, Inc., 8801 N. Main at 45th St., P.O. Box 7366, Houston 8, Tex.
Hays Corp., 742 E. 8th St., Michigan City, Ind.
The Heil Co., TEC Div., 1285 W. 70th St., Cleveland 2, Ohio
Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland 35, Ohio, ADV. p46
Helicoid Gage Div., American Chain & Cable Co., Inc., 929 Connecticut Ave., Bridgeport 2, Conn.
Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.
Helwig Carbon Products, Inc., 2500 N. 30th St., Milwaukee 10, Wis.
Hendrick Mfg. Co., Carbondale, Pa., ADV. p29
Hendrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., P.O. Box 31, Mansfield, La.
Hercules Motors Corp., 101 11 St., S. E., Canton, Ohio
Hercules Powder Co., Hercules Tower, 900 Market St., Wilmington 99, Del. ADV. p36
Hercules Steel Products Co., Galion, Ohio
Herold Mfg. Co., 215 Hickory St., Scranton 5, Pa.
Hevi-Duty Electric Co., A Div. of Basic Products Corp., 304 Hart St., Watertown, Wis.
Hewitt-Robins Incorporated, 666 Glenbrook Rd., Stamford, Conn., ADV. p134
The Hewson Co., Inc., 443 Broad St., Newark 2, N.J.
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa., ADV. p129
Hobart Bros. Co., Hobart Square, Troy 1, Ohio
Hockensmith Corp., Penn, Pa.
Hodag Chemical Corp., 7247 North Central Park, Skokie, Ill.
Hoffman Brothers Drilling Co., Tiona and Ceder Sts., Punxsutawney, Pa.
Hoffman Combustion Engrg. Co., 1780 Southfield Rd., Lincoln Park, Mich.
Holmes Bros., Inc., 510 Junction Ave., Danville, Ill.
Holub Industries, Inc., 413 DeKalb Ave., Sycamore, Ill.
Homelite Textron, Inc., 75 Riverdale Ave., Port Chester, N.Y.
The Homer Mfg. Div., The Ohio Electric Mfg. Co., 142 E. Pearl St., Lima, Ohio
Homestead Valve Mfg. Co., Corapolis, Pa.
Hood Industrial Footwear & Gloves, Watertown 72, Mass.
Hose Accessories Co., 17th St. & Lehigh Ave., Philadelphia 32, Pa.
Hossfeld Mfg. Co., 460-462 W. Third St., Winona, Minn., ADV. p351
The Frank G. Hough Co., 735 Seventh St., Libertyville, Ill.
Howe Scale Co., Rutland, Vt.
Howells Mining Drill Co., Plymouth, Pa.
Hoyt Wire Cloth Co., P.O. Box 1577, Lancaster, Pa., ADV. p161
Huber-Warco Co., Marion, Ohio, ADV. p309
Hughes Tool Co., 5425 Polk Ave., Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Ave., Philadelphia 34, Pa., ADV. p2-3
Hunt Valve Co., Div. of International Basic Economy Corp. (IBEC), 1913 E. State St., Salem, Ohio
Huntington Alloy Products Div., The International Nickel Co., Inc., Huntington 17, W. Va.
Hyatt Bearings Div., General Motors Corp., Harrison, N.J.
Hydreco Div., The New York Air Brake Co., 9000 E. Michigan Ave., Kalamazoo, Mich.
Hyster Co., 2902 N.E. Clackamas St., Portland 8, Ore.
Hy-Test Safety Shoe Div., International Shoe Co., 1509 Washington Ave., St. Louis 66, Mo.

I

I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Gear & Machine Co., 2108 N. Natchez Ave., Chicago 35, Ill.
Illinois Zinc Co., A Div. of Hydrometals, 230 North Michigan Ave., Chicago 1, Ill.
Impact Rotor Tool, Inc., Route 30 East, Irwin, Pa.
Imperial-Cantrell Mfg. Co., P.O. Box 538, Jellico, Tenn.
Industrial Chemicals Div., Spencer Chemical Co., Dwight Bldg., Kansas City 5, Mo.
Industrial Engineering & Const. Co., Inc., First National Bank Bldg., Fairmont, W. Va.
Industrial Nucleonics Corp., 650 Ackerman Rd., Columbus 14, Ohio
Industrial Physics & Electronics Co., 470 So. 10th East, Salt Lake City, Utah
Industrial Rubber Products Co., 815 Court St., Charleston, W. Va.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp., Box 9490, Lansing, Mich.
Infilco Inc., Gale Separator Div., P.O. Box 5033, Tucson, Ariz.
Ingersoll-Rand Co., 11 Broadway New York 4, N.Y.
Inland Steel Co., 30 W. Monroe St., Chicago 3, Ill.
Insley Mfg. Corp., 801 N. Olney St., Indianapolis 1, Ind.; Gen. Offices — Indianapolis, Ind.; Western Regional Office: Pasadena, Calif.
International Harvester Co., 180 N. Michigan Ave., Chicago 1, Ill. ADV. p60-61
International Harvester Co., Motor Truck Div., 180 N. Michigan Ave., Chicago 1, Ill.
International Salt Co., Clarks Summit, Pa.
Interstate Equipment Corp., 433 N. Broad St., Elizabeth 3, N.J.
Iowa Mfg. Co., 916 16 St., N.E., Cedar Rapids, Iowa
The Ironton Engine Co., Farmingdale, N.J.
Irwin-Sensenich Corp., Box 311, Irwin, Pa.
Irvington Div. of Minnesota Mining & Mfg. Co., St. Paul, Minn.

J

Jamison Feeder, Inc., Hunkers, Pa. ADV. p316
Jeffrey Mfg. Co., 922 N. Fourth St., Columbus 16, Ohio, ADV. p88-89
Jenkins Bros., 100 Park Ave., New York 17, N.Y.
Johns-Manville, 22 East 40 St., New York 17, N.Y.
Johns-Manville Plastics Corp., 315 Grant St., Franklin, Pa.
The Johnson-March Corp., 3018 Market St., Philadelphia 4, Pa.
Johnson Plastic Corp., P.O. Box 100, Chagrin Falls, Ohio
G. R. Johnson Loading Supplies, 5027 Butterworth Rd., Mercer Island, Wash.
The R. G. Johnson Co., 25 S. College St., Washington, Pa.
Johnston Pump Co., P.O. Bin K, Pasadena, Calif.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa.
Joy Mfg. Co., 333 Oliver Bldg., Pittsburgh 22, Pa.; Coal Machy. Div. 3021 Banksville Rd., Pittsburgh 16, Pa.; 742 Eighth Ave., P.O. Box 1208, Huntington 14, W. Va.; 453 Main St., Luzerne, Pa.; 1203 Macklind Ave., St. Louis 10, Mo.; 1626 Wazee St., Denver 2, Colo., ADV. p112-113, 156
Joyce-Cridland Co., 2027 East 1st St., Dayton, Ohio
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.

K

K-W Dart Truck Co., 1301 N. Manchester Tfwy., Kansas City 20, Mo., ADV. p318
Kaiser Aluminum & Chemical Sales, Inc., Kaiser Center, 300 Lakeside Dr., Oakland 12, Calif.
Kaiser Refractories & Chemicals Div., Kaiser Aluminum & Chemical Corp., 300 Lakeside Dr., Oakland 12, Calif.
Kanawha Mfg. Co., Charleston 26, W. Va.
Keasbey & Mattison Co., Ambler, Pa.
Keenan Oil Co., 1 Parkway Dr., Cincinnati 12, Ohio
Kelly Mfg. Co., Machine Parts Div., 503-505 Broad St., Charleston 21, W. Va.
Kenco Pump Div. of The American Crucible Products Co., 1305 Oberlin Ave., Lorain, Ohio
Kennametal, Inc., Mining Tool Div. Bedford, Pa. ADV. p301
Kennedy Valve Mfg. Co., Elmira, N.Y.
Kennedy Van Saun Mfg. & Eng. Corp., 405 Park Ave., New York 22, N.Y.
Kensington Steel, Div. of Poor & Co., 505 Kensington Ave., Chicago 28, Ill.
Kern Instruments Inc., 120 Grand St., White Plains, N.Y.
Kersey Manufacturing Co., Inc. P.O. Box 151, Bluefield, Va.
Keystone Carbon Co., 1935 State St., St. Marys, Pa.
Keystone Lubricating Co., 21 & Clearfield Sts., Philadelphia 32, Pa.
Walter Kidde & Co., Inc., 356 Main St., Belleville 9, N.J.
Kidde Ultrasonic & Detection Alarms Div., Walter Kidde & Co., Inc., 356 Brighton Rd., Clifton, N.J.
S. P. Kinney Engineers, Inc., 201 Second Ave., Carnegie, Pa.
Kinney Vacuum Div., The New York Air Brake Co., 3529 Washington St., Boston 30, Mass.
Kirk & Cowin, Inc., 1 18th St., SW, Birmingham, Ala.
Koehring Div. of Koehring Co., 3026 W. Concordia Ave., Milwaukee 16, Wis.
Koppers Co. Inc., Metal Products Div., 200 Scott St., Baltimore 3, Md.
Koppers Co., Inc., Wood Preserving Div., 750-A Koppers Bldg., Pittsburgh 19, Pa.
Koven Fabricators, Inc., 90 E. Dickerson St., Dover, N.J.
Kuhlman Elec. Co., 2565 E. Maple Rd., P.O. Box 288, Birmingham, Mich.

L

Laboratory Equipment Corp., Hilltop Rd., St. Joseph 3, Mich.
LaBour Co., Inc., 1607 Sterling Ave., Elkhart, Ind.
Ladish Co., 5481 S. Packard Ave., Cudahy, Wis.
Laubenstein Mfg. Co., Ashland, Pa.
Layne & Bowler, Inc., Box 6697, Hollywood Sta., Memphis 8, Tenn.
Layne & Bowler Pump Co., P.O. Box 6991, Los Angeles 22, Calif.
Ledeen, Inc., 3350 No. Gilman Rd., El Monte, Calif.
Lee-Norse Co., Charleroi, Pa., ADV. p295
The Leetonia Tool Co., 142 Main St., Leetonia, Ohio

Leman Machine Co., S. Railroad St., Portage, Pa.

Le Roi Div., Westinghouse Air Brake Co., Sidney, Ohio, ADV. p117

Leschen Wire Rope Div., H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo., ADV. p65

R. G. LeTourneau, Inc., 2395 S. MacArthur, Longview, Texas

LeTourneau - Westinghouse Co., 2301 N.E. Adams St., Peoria, Ill., ADV. p136-137

Linatex Corp. of America, Drawer "D" Stafford Springs, Conn., ADV. p43

Linco Co., Export, Pa.

The Lincoln Electric Co., 22801 St. Clair Ave., Cleveland 17, Ohio

Lincoln Engrg. Co., Div. of McNeil Mach. & Engrg. Co., 5701 Natural Bridge Ave., St. Louis, Mo.

Link-Belt Co., Dept CAMGL-61 Purdential Plaza, Chicago 1, Ill., ADV. p27

Link-Belt Speeder Corp., Cedar Rapids, Iowa

Lippmann Engineering Works Inc., 4603 West Mitchell St., Milwaukee 14, Wis.

Lister-Blackstone, Inc., 42-32 21st St., Long Island City 1.

Herbert S. Littlewood, R.D. 3, Irwin, Pa.

Peter F. Loftus Corp., First National Bank Bldg., Pittsburgh 22, Pa.

Long-Airdox Co., Div. of Marmon-Herrington Co., Inc., P.O. Box 331, Oak Hill, W. Va., Chicago, Ill. ADV. p305

E. J. Longyear Co., 76 So. 8th St., Minneapolis 8, Minn., ADV. p355

Lubriplate Div., Fiske Brothers Refining Co., 129 Lockwood St., Newark 5, N.J.

Ludlow Saylor Wire Cloth Co., 634 South Newstead, St. Louis 10, Mo., ADV. p341

Ludlow Valve Mfdg. Co., Inc., P.O. Box 388, Troy 1, N.Y.

Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.

Lukens Steel Co., 447 Services Bldg., Coatesville, Pa.

M

Mack Trucks, Inc., 1355 West St., Plainfield, N.J.

Macwhyte Wire Rope Co., 2931 14th Ave., Kenosha, Wis., ADV. p280

Magichemical Co., 121 Crescent St., Brockton 2, Mass.

Magnetic Engrg. & Mfg. Co., 851 Van Houten Ave., Clifton, N.J.

Maintenance Engineering Corp., P.O. Box 10426, Pittsburgh 34, Pa.

Majac, Inc., Sub. of Blackstone Corp., 23rd St., Sharpsburg, Pittsburgh 15, Pa.

Mancha Storage Battery Locomotive, Div. Goodman Mfg. Co., Halsted St., & 48th Pl., Chicago 9, Ill.

Manhiem Mfg. & Belting Co., 470 Stiegel St., Manheim, Pa.

Manitowoc Engineering Corp., S. 16th St., Manitowoc, Wis.

Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. Muskegon, Mich.

Manzel, Unit of Houdaille Industries, Inc., 315 Babcock St., Buffalo 10, N.Y.

Marathon Coal Bit Co., Inc., Box 391, Montgomery, W. Va.

Marietta Concrete Div., American-Marietta Co., Box 669, Marietta, Ohio, ADV. p353

Marietta Manufacturing Co., P.O. Box 17, Point Pleasant, W. Va.

Marion Handle Mills, Inc., Marion, Va.

Marion Metal Products, Co., Chaney Ave. and Otis St., Marion, Ohio

Marion Power Shovel Co., a div. of Universal Marion Corp., Marion, Ohio, ADV. p16

Marland One-Way Clutch Co., Elm Ave. & Washington St., La Grange, Ill.

Marlin-Rockwell Corp., 402 Chandler St., Jamestown, N.Y.

Marlow Pumps, Div. of Bell & Gossett Co., Box 200, Midland Park, N.J.

Marman Div., Aeroquip Corp., 11214 Exposition Blvd., Los Angeles 64, Calif.

E. F. Marsh Engrg. Co., 4324 W. Clayton Ave., St. Louis 10, Mo.

Martin Engrg. Co., Cab Road Neponset, Ill.

Martindale Electric Co., 1307 Hird Ave., Cleveland 7, Ohio

Master Bronze Powder Co., Inc., 538-548 W. State St., Calumet City, Ill.

The Master Electric Co., Div. of Reliance Electric & Engrg. Co., 126 Davis Ave., Dayton 1, Ohio

Mayo Tunnel & Mine Equipment, Lancaster, Pa.

McDowell Co., Inc., 113 St. Clair Ave., N.E., Cleveland 14, Ohio

McDowell Mfg. Co., 301 Stanton Ave., Pittsburgh 9, Pa. ADV. p353

The McKay Co., 1005 Liberty Ave., Pittsburgh 22, Pa.; Plant — Grantley Rd., York, Pa.

McLanahan Corp., Hollidaysburg, Pa., ADV. 8

McLaughlin Mfg. Co., Inc., 801 E. Cass St., Joliet, Ill.

McNally-Pittsburg Mfg. Corp., 207 West Third St., Pittsburg, Kan.

Meckum Engineering, Inc., 53 W. Jackson Blvd., Chicago 4, Ill.

Megator Corp., 930 Manchester Ave., Pittsburgh 12, Pa.

Merrick Scale Mfg. Co., 184 Autumn St., Passaic, N.J., ADV. p292

Metal Carbides Corp., 6001 Southern Blvd., Youngstown 12, Ohio

Metal & Thermit Corp., Rahway, N.J.

Metallurgical Products Dept., General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich., ADV. p123

Midland Pipe & Supply Co., 2829 S. 61st Ct., Chicago 50, Ill.

Mine Safety Appliances Co., 201 North Braddock Ave., Pittsburgh 8, Pa., ADV. p22-23

Mine and Smelter Supply Co., Manufacturing Div., P.O. Box 9401 (3800 Race St.), Denver, Colo., ADV. p58

Mine Ventilation Systems, Inc., Box 382, Madison, W. Va.

Miners Hardware Supply Co., 215 Martin Bldg., Pittsburgh 12, Pa., ADV. p340

Mining Machine Parts, Inc., 13700 Broadway Ave., Cleveland 25, Ohio

Mining Progress, Inc., P.O. Box 3, Highland Mills, N.Y., ADV. p17

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne and Windrim Ave., Phila. 44, Pa.

Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn.

Mitchell Industrial Tire, Inc., Box 468, Chattanooga, Tenn.

Mobil Oil Co., A Div. of Socony Mobile Oil Co., Inc., 150 E. 42nd St., New York 17, N. Y.

Mobile Aerial Towers, Inc., 1730 N. Harrison St., Fort Wayne, Ind.

Mobile Drilling, Inc., 960 North Pennsylvania St., Indianapolis, 4, Ind.

Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.

Monsanto Chemical Co., 800 N. Lindbergh Blvd., St. Louis 66, Mo.

The Moore Co., Quarrier and Bradford St., Charleston, W. Va.

Morris Machine Works, 31 E. Genesee St., Baldwinsville, N. Y.

Morse Bros. Machinery Co., 2900 Brighton Blvd., Denver 1, Colo.

Morse Chain Co., A Borg-Warner Industry, Ithaca, N. Y.

Morton Salt Co., 110 No. Wacker Dr., Chicago 6, Ill.

Mosebach Electric & Supply Co., 1115 Arlington Ave., Pittsburgh 3, Pa.

T. J. Moss Tie Co., 700 Security Bldg., St. Louis 2, Mo.

Motor Exchange and Supply Co., Hines, W. Va.

Motorola Communications & Electronics, Inc., 4501 West Augusta Blvd., Chicago 51, Ill.

Mott Core Drilling Co., 830 Eighth Ave., Huntington 17, W. Va.

Murphy Diesel Co., 5317 West Burnham St., Milwaukee, Wis.

Myers-Whaley Co., P. O. Box 789, Knoxville 1, Tenn.

N

Nachold & U. S. Signal Co., 4777 Louisville Ave., Louisville 9, Ky.

Nagle Pumps, Inc., 1237 Center Ave., Chicago Heights, Ill.

Nash Engineering Co., South Norwalk, Conn.

Nathan Mfg. Div., Wegner Machinery Corp., 35-41 11th St., Long Island City 6, N. Y.

National Air Vibrator Co., 435 Literary Rd., Cleveland 13, Ohio

National Carbon Co., Division of Union Carbide Corp., 270 Park Ave., New York 17, N. Y.

National Electric Coil, Div. of McGraw-Edison Co., 800 King Ave. Columbus 16, Ohio

National Electric Div., H. K. Porter Co., Inc., Porter Bldg., Pittsburgh 19, Pa.

National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.

National Castings Co., 10600 Quincy Ave., Cleveland 6, Ohio, ADV. p315

National Mine Service Co., 2530 Koppers Bldg., Pittsburgh 19, Pa.; Alabama Div., Birmingham, Ala.; Clarkson Div., Nashville, Ill.; Bemeco Div., Beckley W. Va. All-State Div., Logan, W. Va.; Kentucky-Virginia Div., Jenkins, Ky.; Whiteman Div., Indiana, Pa.; Ashland Div., Ashland, Ky.; Anthracite Div., Mt. Carmel, Pa.; Western Kentucky Div., Madisonville, Ky.; Greensburg Div., Ashland, Ky.; Mountaineer Div., Morgantown, W. Va.; National Mine Service (Canada) Ltd., Elliot Lake, Ontario, ADV. p327

National Powder Co., Eldred, Pa.

National Supply Div., Armco Steel Corp., P.O. Box 416, Pittsburgh 30, Pa.

National Tube Div., United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.

Naylor Pipe Co., 1262 E. 92 St. Chicago 19, Ill.

The Neff & Fry Co., 320 Elm St., Camden, Ohio

Newark Wire Cloth Co., 351 Verona Ave., Newark 4, N. J.

New Departure Div., General Motors Corp., 269 N. Main St., Bristol, Conn.

New York Central System, 466 Lexington Ave., New York, N.Y.

New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.

The Nolan Co., Bowerston, Ohio, ADV. p37

Nordberg Mfg. Co., 3073 South Chase Ave., Milwaukee 1, Wis.

Norma-Hoffman Bearings Corp., Stamford, Conn.

North American Gear Co., Box 7, Blairsville, Pa.

Northern Blower Div., Buell Engineering Co., Inc., 6409 Barberton Ave., Cleveland 2, Ohio ADV. p148

Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.

Norton Co., 1 New Bond St., Worcester 6, Mass.

Norton-Tividale, Ltd., 307 N. Michigan Ave., Chicago 1, Ill. ADV. 320-321

NoVo Div., Industrial Enterprises Inc., 9705 Cottage Grove Ave., Chicago 28, Ill.

O

Ohio Brass Co., Mansfield, Ohio, ADV. p63

Ohio Carbon Co., 12508 Berea Road, Cleveland 11, Ohio

Ohio Oil Co., Findlay, Ohio

The Okonite Co., Canal St., Passaic, N.J. ADV. p157

Olin-Mathieson Chemical Corp., Explosives Operations, Energy Div., East Alton, Ill.

Oliver Corp., 400 West Madison St., Chicago 6, Ill.

Onox, Inc., 121 Second St., San Francisco 5, Calif.

Kurt Orban Co., Inc., Industrial Equipment Div., 87 Greenwich Ave., Greenwich, Conn.

The Ore & Chemical Corp., 80 Broad St., New York 4, N. Y.

Ore Reclamation Co., 301 No. Connell Ave., Picher, Okla.

Orefraction, Inc., 7425 Thomas St. Pittsburgh 8, Pa.

Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.

Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.

Owatonna Tool Co., 652 Cedar St., Owatonna, Minn.

P

PLM Products, Inc., 3871 W. 150th St., Cleveland 11, Ohio, ADV. p160

Page Engineering Co., Clearing Post Office, Chicago 38, Ill.

Page Steel & Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.

The Palnut Co., Div. of United-Carr Fastener Corp., Mountainside, N.J.

Paltech Co., Thayer Pond Rd., New Canaan, Conn.

Pangborn Corp., 670 Pangborn Blvd., Hagerstown, Md.

Paris Mfg. Co., Paris, Ill.

Parker Fittings & Hose Div., and Parker Hydraulics Div., 17325 Euclid Ave., Cleveland 12, Ohio

The Parkersburg Rig & Reel Co., Div. of Parkersburg - Aetna Corp., 1958 Crawford St., Parkersburg, W. Va.

Pasadena Hydraulics, Inc., 1433 Lidcombe, El Monte, Calif., ADV. p355

Pattin Manufacturing Co., Div. The Eastern Co., P.O. Box 659, Marietta, Ohio

Peerless Hardware Mfg. Co., 1285 Manheim Pike—P.O. Box 667, Lancaster, Pa.

Peerless Photo Products, Inc., Shoreham, N.Y.

Peerless Pump, Hydrodynamics Div., Food Machinery & Chemical Corp., 301 West Ave. 26, Los Angeles 31, Calif.

Penn Machine Co., 106 Station St., Johnstown, Pa.; 905 Porter Bldg., Pittsburgh 19, Pa.; 410 W. 15th St., Huntington, W. Va.

Pennsylvania Crusher Div., Bath Iron Works Corp., Room 1711, West Chester, Pa., ADV. 3rd Cover

Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.; Masonry Drill Div., 1215 Chartiers Ave., Pittsburgh 20, Pa.

Pennsylvania Electric Coil Corp., 1301 Saw Mill Run Blvd., Pittsburgh 26, Pa.

Pennsylvania Pump & Compressor Co., Easton, Pa.

Pennsylvania Refining Co., Butler, Pa.

Perfection Steel Body Co., East St., Galion, Ohio

Perkin Electronics Corp., 345 Kansas St., El Segundo, Calif.

Peterson Filters & Engineering Co., 1949 S. Second West, P.O. Box 606, Salt Lake City 10, Utah, ADV. p140

Petitbone Mulliken Corp., Haiss Div., 1212 E. Dominick St., Rome, N.Y.

J. B. Pfister Co., 662 Ohio St., Terre Haute, Ind.

Phelps Dodge Copper Products Co., 300 Park Ave., New York 22, N.Y. ADV. p47

Phoenix Steel Corp., Structural & Tube Divisions, Phoenixville, Pa.; Plate Div., Claymont, Del.; Phoenix Bridge Co., Phoenixville, Pa.

Phoenix Products Co., Inc., 4737 North 27th St., Milwaukee 9, Wis.

Pierce Management Corp., P. P. & L. Bldg., Scranton 3, Pa.

Pioneer Engineering, Div. of Poor & Co., 3200 Como Ave., Minneapolis 14, Minn.

Pitman Manufacturing Co., Garner Ave. & Duck Rd., Grandview, Mo.

Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.

Pittsburgh Gear Co., Neville Island, Pittsburgh 25, Pa.

Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.

Plymouth Locomotive Works, Div. of the Fate-Root-Heath Co., Plymouth, Ohio

Plymouth Rubber Co., Inc., 51 Revere St., Canton, Mass.

H. K. Porter Co., Connors Steel Div., West Virginia Works, P.O. Box 118, Huntington, W. Va.; Connors Works, P.O. Box 2562, Birmingham, Ala.

H. K. Porter Co., Inc., National Electric Div., Porter Bldg., Pittsburgh 19, Pa.

H. K. Porter, Inc., 74 Foley St., Somerville Mass.

H. K. Porter Company, Refractories Dept., 14th Floor—Porter Bldg., Pittsburgh 19, Pa.

Porto Pump, Inc., 19735 Ralston, Detroit 3, Mich.

The Post-Glover Electric Co., P.O. Box 709, Covington, Ky.; Plant-Kenton Lands Rd., Erlanger, Ky., ADV. p138
Preco Incorporated, 6300 E. Slauson Ave., Los Angeles 22, Calif.
Prime Mover Co., Muscatine, Iowa
K. Prins & Associates, Wellston, Ohio
Productive Equipment Corp., 2926 West Lake St., Chicago 12, Ill.
Propellex Chemical Div., Chromoloy Corp., P.O. Box 187, Edwardsville, Ill.
Proto Tool Co., Div. of Pendleton Tool Industries, Inc., 2209 Santa Fe Ave., Los Angeles 54, Calif.
Frank Prox Company, Inc., 1201 South First St., Terre Haute, Ind. ADV. p293
Pulmosan Safety Equip. Co., 644 Pacific St., Brooklyn, N. Y.
Pure Carbon Co., Inc., 441 Hall Ave., St. Marys, Pa.
The Pure Oil Co., 620 E. Broad St., Columbus, Ohio

Q

"Quick-Way" Truck Shovel Co., 2401 E. 40th Ave., Denver, Colo.

R

R-P & C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.
Raybestos Manhattan, Inc., Manhattan Rubber Div., 42 Townsend St., Passaic, N. J.
Read, Davis, Consulting Engineer, 1020 Adams St., Sturgis, Ky.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reeves Pulley Co. Div., Reliance Electric & Engineering Co., 1225 7th St., Columbus, Ind.
REICHdrill Div., Chicago Pneumatic Tool Co., Howard St., Franklin, Venango Co., Pa.
Reid Belt & Rubber Co., Inc., 917 Grant St., Bluefield, W. Va.
Geo. P. Reintjes Co., P.O. Box 856, Kansas City 41, Mo.
Reliance Elec. & Eng. Co., 24701 Euclid Ave., Cleveland 17, Ohio
Reliance Insurance Co., 401 Walnut St., Philadelphia 6, Pa.
Remaly Mfg. Co., Inc., Tamaqua, Pa.
Rema-Tech, Inc., 2 Park Ave., New York 16, N. Y.
Remington Arms Co. Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Republic Cresoting Co., Div. of Reilly Tar & Chemical Corp., 1615 Merchants Bank Bldg., Indianapolis 4, Ind.
Republic Rubber Div., Lee Rubber & Tire Co., Youngstown 1, Ohio
Republic Steel, Republic Bldg., Cleveland 1, Ohio
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N. Y.
Revere Corp. of America, Sub. of Neptune Meter Co., Wallingford, Conn.
Rexarc, Inc., Rexarc Pl., West Alexandria, Ohio
Reynolds Metals Co., P.O. Box 2346ZH, Richmond 18, Va.
Rice Pump & Machine Co., 600 Park St., Belgium, Wis.
Ridge Equipment Co., Fallentimber, Pa. ADV. p68
The Ridge Tool Co., 400 Clark St., Elyria, Ohio
Riegel Textile Corp., 260 Madison Ave., New York, N. Y.; Glove Div., Conover, N. C.
Robbins Machine & Mfg. Co., P.O. Box 281, Oneonta, Ala.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Roberts & Schaefer Company, Division Thompson-Starrett Company, Inc., 201 N. Wells St., Chicago 6, Ill.
Robinson & Robinson, Inc., Union Bldg., Charleston, W. Va.
Robinson Ventilating Co., 280 Henderson St., Zelienople, Pa.
Rochester Ropes Inc., Culpeper, Va.
Rockbestos Wire & Cable Co., Div. of Cerro Corp., Nicoll and Canner Sts. New Haven 4, Conn.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
Rockwell-Stanford Corp., Brake Div., Ashtabula, Ohio
Rockwell-Standard Corp., Transmission and Axle Div., 100-400 Clark Ave., Detroit 32, Mich.
John A. Roebling's Sons Div., The Colorado Fuel & Iron Corp., 640 South Broad St., Trenton 2, N.J., ADV. p52
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N.Y.
Rome Cable Div. of Alcoa, 421 Ridge St., Rome, N.Y., ADV. p153
Rotts-Connersville Blower Div., Dresser Industries, Inc., 900 W. Mount St., Connersville, Ind.
Ross Screen & Feeder Co., 100 Quimby St., Westfield, N. J.
The Ruberoid Co., 733 Third Ave., New York 17, N. Y.
Ruger Equipment, Inc., 615 W. 4th St., Uhrichsville, Ohio
Russell Mfg. Co., Middletown, Conn., ADV. p333
Rust-Oleum Corp., 2425 Oakton St., Evanston, Ill.
Ruttmann Construction Co., 425 W. Walker St., Upper Sandusky, Ohio, ADV. p141
Rydin Railway Equip. Co., 224 S. Michigan Ave., Chicago 4, Ill.
Joseph T. Ryerson & Son, Inc., P.O. Box 8000A, Chicago 80, Ill.

S

SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa. ADV. p147
Salem-Brosius, Inc., P. O. Box 2222, Pittsburgh 30, Pa.
The Salem Tool Co., 767 S. Ellsworth Ave., Salem, Ohio, ADV. p144-145
Sanford-Day Corp., P. O. Box 1511, Knoxville 9, Tenn.
Sauerman Bros., Inc., 620 South 28th Ave., Bellwood, Ill.
W. J. Savage Co., 912 Clinch Ave., S.W. Knoxville 16, Tenn.
Scandura, Inc., 112 Keswick Ave., P. O. Box 949, Charlotte 1, N.C.
Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh 22, Pa.
Schield Bantam Co., 221 Park St., Waverly, Iowa
Schramm Inc., 871 E. Virginia Ave., West Chester, Pa. ADV. p155
Schroeder Bros. Corp., Nichol Ave., Box 72, McKees Rocks Pa., ADV. p32
Scientific & Process Instruments Div., Beckman Instruments, Inc., 2500 Harbor Blvd., Fullerton, Calif.
Scranton Electric Construction Co., P. O. Box 1250, Scranton, Pa.; Branch—382 S. Center St., Pottsville, Pa.
Screen Equipment Co., Inc., Buffalo 25, N. Y.
Screw and Bolt Corp. of America, P. O. Box 1708, Pittsburgh 30, Pa.
Security Engrg. Div., Dresser Industries, Inc., 3400 W. Illinois, Dallas, Texas. ADV. p284
Seiberling Rubber Co., Akron 9, Ohio
Shaft and Development Machine Co., 808 Newhouse Bldg., Salt Lake City 11, Utah
Sheffield Div., Armco Steel Corp., Sheffield Sta., Kansas City, Mo.
Shell Oil Co., 50 W. 50th St., New York 20, N.Y., ADV. p24
Shepard Niles Crane & Hoist Corp., Schuyler Ave., Montour Falls, N. Y.
R. H. Sheppard Co., Inc., Hanover, Pa.
Shirley Machine Co., 725 Liberty Ave., Pittsburgh 22, Pa.
Sika Chemical Corp., 35 Gregory Ave., P.O. Box 899, Passaic, N.J.
Silver Engineering Works, Inc., 3309 Blake St., Denver 5, Colo.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass. ADV. p13
Simplicity Engineering Co., Durand, Mich.
Sinclair Refining Co., 600 Fifth Ave., New York 20, N.Y.
J. K. Smit & Sons, Inc., Murray Hill, N. J.
Smith Tool Co., Box 431, Compton, Calif.
Smith Engineering Works, 502 East Capitol Dr., Milwaukee, Wis.
F. S. Smithers & Co., 1 Wall St., New York 5, N.Y.
Snap-On Tools Corp., 8132 28 Ave., Kenosha, Wis.
The Snow-Nabstedt Gear Corp., 251 Welton St., Hamden 7, Conn.
Southwestern Engineering Co., 4800 Santa Fe Ave., Los Angeles 58, Calif.
Spang & Company, P. O. Box 751, Butler, Pa.
Sprague & Henwood Inc., 221 W. Olive St., Scranton, Pa.
Spraying Systems Co., Randolph St., Bellwood, Ill.
W. F. Sprengnether Instrument Co., Inc., 4576 Swan Ave., St. Louis 10, Mo.
Sprout Waldron & Co., Inc., Muncy, Pa.
Stackpole Carbon Co., Stackpole St., St. Marys, Pa.
Stahlunion Corp., 350 5th Ave., New York, N.Y.
W. R. Stamler Corp., Paris, Ky.
Standard Carbon Co., P. O. 49, Steubenville, Ohio
Standard Steel Corp., 5001 S., Boyle Ave., Los Angeles 58, Calif.
Stearns Magnetic Products, div. of Indiana General Corp., 635 So. 28th St., Milwaukee 46, Wis. ADV. p50
The Stearns-Roger Mfg. Co., 660 Bannock St., P. O. Box 5888, Denver 17, Colo.
Steel-Bilt Construction Co., P. O. Box 309, Bridgeville, Pa.
Steelcraft Mfg. Co., 9017 Blue Ash Rd., Cincinnati 42, Ohio
Stephens-Adamson Mfg. Co., 230 Ridgeway Ave., Aurora, Ill.
Sterling Electric Motors, Inc., A Sub. of Hathaway Instruments, Inc., 5401 Telegraph Rd., Los Angeles 22, Calif.
Sterling Steel Casting Co., P. O. Box 230, East St. Louis, Ill.
Stewart-Warner Corp., Alemite Div., 1826 Diversey Pkway., Chicago 14, Ill.
Stonhard Co. Inc., 401 N. Broad St., Philadelphia 8, Pa.
Stoody Co., 11928 East Slauson Ave., Whittier, Calif.
Straub Mfg. Co., Inc., 8383 Baldwin St., Oakland 21, Calif.
Stulz-Sickles Co., 929-39 Julia St., Elizabeth, N. J.
Sturtevant Mill Co., 103 Clayton St., Dorchester, Boston 22, Mass.
Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa., ADV. p297
Superior Carbon Products, Inc., 9115 George Ave., Cleveland 5, Ohio
Peter O. Sutphen Co., P. O. Box 90, Everett, Pa.
Syntron Co., 975 Lexington Ave., Homer City, Pa.

T

Talk-A-Phone Co., 5013 No. Kedzie Ave., Chicago 25, Ill.
Tamping Bag Co. Div., Pickard Industries, Inc., Mt. Vernon, Ill.
Taylor-Wharton Co. Div., Harsco Corp., High Bridge, N. J.
Templeton, Kenly & Co., 16th & Gardner Rd., Broadview, Ill., ADV. p354
Templeton-Matthews Corp., 905 Sycamore Bldg., Terre Haute, Ind.
Texaco Inc., 135 East 42nd St., New York 17, N.Y. p119
Thermex Metallurgical, Inc., Lakehurst, N.J. ADV. p354
Thermoid Div., H. K. Porter Co., Inc., 200 Whitehead Rd. Trenton 6, N.J. ADV. p66-67
The Thew Shovel Co., Lorain, Ohio
G. C. Thomas Mfg. Co., Box 646, Greensburg, Pa.
Thomas Flexible Coupling Co., A Sub. of Koppers Co., Inc., Main Ave. and Biddle St., Warren, Pa.
Thompson Products Valve Div., Thompson Ramo Wooldridge Inc., 1455 E. 185th St., Cleveland 10, Ohio
Thor Power Tool Co., 175 N. State St., Aurora, Ill.
Thurman Scale Co., Div. Thurman Mfg. Co., 1939 Refugee Rd., Columbus, Ohio
Tidewater Oil Co., 660 Madison Ave., New York 21, N. Y.
The Timken Roller Bearing Co., 1835 Dueber Ave., S.W., Canton 6, Ohio
Toledo Pipe Threading Machine Co., P. O. Box 1678, Toledo 3, Ohio
The Tool Steel Gear & Pinion Co., 211 Township Ave. Elmwood Pl., Cincinnati 16, Ohio
Torrington Co., 59 Field St., Torrington, Conn.
Trabon Engineering Corp., 28815 Aurora Rd., Solon 39, Ohio
Bertrand P. Tracy Co., 919 Fulton St., Pittsburgh 33, Pa.
Transall, Incorporated, P. O. Box 6755, Crestwood Blvd., Birmingham 10, Ala.
Traylor Engineering & Mfg. Div. of Fuller Co., Allentown, Pa.
Triangle Conduit & Cable Co., Inc., Box 711, Triangle & Jersey Aves., New Brunswick, N. J.
Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12, Wis.
Trojan Powder Co. 17 N. 7th St. Allentown, Pa.
Tube Turns, Div. of Chemetron Corp., 224 E. Broadway, Louisville 1, Ky.
Tulsa Products, Div. of Vickers Incorporated, 731 East First St., Tulsa 20, Okla.
Tweco Products, Inc., 1450 South Mosley, Box 666, Wichita 1, Kan.
Twin Disc Clutch Co., Racine, Wis.; Hydraulic Div. and Export Div., Rockford, Ill.
W. S. Tyler Co., 3615 Superior Ave., Cleveland 14, Ohio, ADV. 4th Cover
Tyson Bearing Co., Div. of S-K-F Industries, Inc., Massillon, Ohio

U

Union Switch & Signal Div. of Westinghouse Air Brake Co., Pittsburgh 18, Pa., ADV. p133
Union Wire Rope, Armco Steel Corp., 2130 Manchester Ave., Kansas City 26, Mo., ADV. p106-107
Unit Crane & Shovel Corp., 6411 West Burnham St., Milwaukee 19, Wis.
U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los Angeles 54, Calif.
United States Pipe & Foundry Co., 3300 First Ave., N., Birmingham 2, Ala.
United States Rubber Co., 1230 Ave. of the Americas, New York 20, N.Y., ADV. p78-79
United States Safety Service Co., 1535 Walnut St., Kansas City 8, Mo.
United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa., ADV. p335
Universal Road Machinery Co., Kingston, N. Y.
Universal Vibrating Screen Co., Deane Blvd. & St. Paul R.R., Racine, Wis.
The Upson-Walton Co., 12515 Elmwood Ave., Cleveland 11, Ohio
Utility Mine Equipment Co., 1010 Collingwood Rd., St. Louis 32, Mo.

V

Valvoline Oil Co., Div. of Ashland Oil & Refining Co., 639 Third Ave., Freedom, Pa.
R. T. Vanderbilt Co., Inc., 230 Park Ave., New York, N. Y.
Varel Mfg. Co., Inc., 9230 Denton Dr., P. O. Box 13146, Dallas 20, Texas
Vascoloy-Ramet Corp., 800 Market St., Waukegan, Ill., ADV. p348
Viber Co., 726 S. Flower St., Burbank, Calif.
Vibration Measurement Engineers, 725 Oakton Ave., Evanston, Ill.
Vickers Incorporated, Administrative & Engineering Center, Detroit 32, Mich.
Victaulic Co. of America, Dept. CM Box 509, Elizabeth, N. J.
Visking Co., Plastics Div., 6733 W. 65th St., Chicago 38, Ill.
Vulcan Iron Works Co., 2961 South Fox St., Englewood (Denver), Colo.

W

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 33, Mo.
Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.
O. W. Walvoord, Inc., 301 Detroit St., Denver 6, Colo.
Walworth Co., 750 Third Ave., New York 17, N. Y.
Warner Laboratories, Inc., Cresson, Pa. ADV. p162
Warren Refining & Chemical Co., 5151 Denison Ave., Cleveland 2, Ohio
Watt Car & Wheel Co., Barnesville, Ohio

Waukesha Motor Co., West St. Paul Ave., Waukesha, Wis.
The Weatherhead Co., 300 E. 131st St., Cleveland 8, Ohio
Webster Mfg., Inc., West Hall St., Tiffin, Ohio
Wedge Wire Corp., Gas St. & N.P.R.R., Wellington, Ohio, ADV. p 302
Paul Weir Co., Inc., 20 N. Wacker Drive, Chicago 6, Ill.
S. K. Wellman Co., 200 Egbert Rd., Bedford, Ohio
WEMCO Div., Western Machinery Co., 650 Fifth St., San Francisco 7, Calif., ADV. p154
West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
West Virginia Armature Co., P. O. Box 1460, Bluefield, W. Va.
West Virginia Belt Repairs, Inc., P. O. Box 32, Mount Hope, W. Va.
Western Insulated Wire Co., 2425 East 30 St., Los Angeles 58, Calif.
Western Precipitation Div., Joy Mfg. Co., 1000 West Ninth St., Los Angeles 54, Calif.
Westinghouse Electric Corp., P. O. Box 2278, Gateway 3, Pittsburgh 30, Pa., ADV. p40-41, 158-150
Westinghouse Electric Corp., Sturtevant Div., Hyde Park 36, Mass.
Wheelabrator Corp., 1476 S. Byrkit St., Mishawaka, Ind.
Wheeler Electronic Corp., Sub. of Sperry Rand Corp., 150 East Aurora St., Waterbury, Conn.
White Diesel Engine Div., The White Motor Co., Springfield, Ohio
The White Motor Co., Lansing Div., 1331 S. Washington St., Lansing 20, Mich.
The Whitmore Mfg. Co., P. O. Box 1640, Station C, Cleveland 4, Ohio
Whiting Corp., Harvey, Ill.
The Whitney Chain Co., a sub of Foote Bros. Gear & Machine Corp., 4545 S. Western Blvd., Chicago 9, Ill.
The Wilbur & Williams Co., Inc., 756 Pleasant St., Norwood, Mass.
Wilcox Mfg. Co., P. O. Box 217 Raleigh, W. Va.
Wild Heerbrugg Instruments, Inc., Main & Covert Sts., Port Washington, N.Y., ADV. p325
Wiley Mfg. Co., Port Deposit, Md.
A. R. Wilfley & Sons, P. O. Box 2330, Denver 1, Colo., ADV. p311
Williams Patent Crusher & Pulv. Co., 810 Montgomery St., St. Louis 6, Mo.
Wilmot Engineering Co., 8 West Broad St., Hazleton, Pa. ADV. p303
L. J. Wing Mfg. Co., Div. of Aero Supply Mfg. Co., Inc., 303 Vreeland Mills Rd., Linden, N. J.
Winslow Government Standard Scale Works, Inc., 35th & Hawthorne, Dept. B140, Terre Haute, Ind.
Winter-Weiss Co., 2201 Blake St., Denver 5, Colo.
Wire Rope Corp. of America, Inc., 609 North Second St., St. Joseph, Mo.
Wisconsin Motor Corp., Milwaukee 46, Wis.
Wise Co., Inc., O. B., P. O. Box 42, 2519 Cherry Arcade, Knoxville 1, Tenn.
The Wood Shovel & Tool Co., L. D. 818, Piqua, Ohio
T. B. Woods Sons Co., Chambersburg, Pa.
J. W. Woomer & Associates, 821 Oliver Bldg., Pittsburgh 22, Pa.
Worthington Corp., 421 Worthington Ave., Harrison, N. J.
Wright Power Saw & Tool Corp., Div. of Thomas Industries, Inc., 1419 Illinois Ave., Sheboygan, Wis.
Wyandotte Chemicals Corp., Michigan Alkali Div., Wyandotte, Mich.

Y

Yale & Towne Mfg. Co., 11000 Roosevelt Blvd., Philadelphia 15, Pa.
Yardley Plastics Co., 142 Parsons Ave., Columbus 15, Ohio
Yardney Electric Corp., 40 Leonard St., New York 13, N. Y.
The Youngstown Sheet and Tube Co., Youngstown 1, Ohio

Guidebook Advertisers

District Sales Offices, Distributors, Sales Agents

Listed Geographically for Easy Reference

This listing of sales offices, distributors and/or sales agents is designed to help Guidebook users quickly locate their nearest source of supply for manufacturers advertising in this issue. A company name in **black-face type** in the Classified Product Directory (p 285) notes that more information on products offered by that manufacturer is available in advertisements on pages listed in the Directory of Manufacturers p 357 or in the Advertisers Index on p 380.

A

ACME-HAMILTON MANUFACTURING CORP.
P. O. Box 361, Meade St., Trenton 3, New Jersey

DISTRIBUTORS

ILLINOIS
Chicago: Acme-Hamilton Mfg. Corporation, 810 W. Washington Blvd., Monroe 68145
PENNSYLVANIA
Pittsburgh: Consolidated Rubber Corp., 230 Blvd. of Allies, Court 11097

AEROQUIP CORPORATION
Jackson, Michigan

DISTRICT SALES OFFICES
NORTH CAROLINA
Greensboro: Cross Sales & Engineering Co., P. O. Box 794, 824 Winston St., Broadway 5-6365

DISTRIBUTORS
ALABAMA
Birmingham: Cummins Diesel Sales, 1001 N. 4th Ave, Mill & Mine Supply Co., 3513 11th Ave., N.
Mobile: Allied Auto Parts, 265 St. Louis St.
Montgomery: Dixie Trailer & Brake Service, 1961 Bell St.
ILLINOIS
Chicago 7: Chicago Tire & Rubber Co., 850 Washington Blvd.
Decatur: Midstate Machinery Co., 359 E. Main St.
E. St. Louis: Illinois Electric Works, Inc., 1300-10 Missouri Ave.
INDIANA
Evansville 7: Hocker Power Brake Co., 3rd & Ingle at Carpenter
KENTUCKY
Ashland: National Mine Service Co., Ashland Plant, P. O. Box 888
Jenkins: National Mine Service Co., Kentucky-Virginia Div., P. O. Box 872
Madisonville: National Mine Service Co., Western Kentucky Div., 132 East Center St.
PENNSYLVANIA
Harrisburg: Safety Sales & Service Corp., P. O. Box 1129
Indiana: National Mine Service Co., Whiteman Div., 1260 Maple St.
Pittsburgh 6: The Cypher Co., 1201 Washington Blvd.
Pittsburgh 3: Transmission Equip. Co., 1200 Muriel St.
VIRGINIA
Portsmouth: Morse-Parker Motor Supply Co., P. O. Box 587
Norfolk: Diesel Injection Sales & Service Inc., 808 Union. Tidewater Supply Co., 501 W. 24th
Richmond: Cummins Diesel Sales & Service, P. O. Box 9426
Standard Parts Corp., 500 E. 9th Rd.
Roanoke: Standard Parts Corp., 4117 Williamson Rd.
Tidewater Supply Co.
Salem: Diesel Injection Sales & Service, Inc., 1016 Delaware St.
Winchester: Valley Distributors Inc., 22 Amherst St.
WEST VIRGINIA
Beckley: National Mine Service, Bemeco Div., P .O. Box 32
Bluefield: Bluefield Hardware Co.
Logan: National Mine Svc., All-State Div., P. O. Box 1671
Charleston: A&I Suppl yCo., 614 Virginia St.
Cummins Engine of W. Va., Box 527
Kanawha Steel & Equipment Co., 112 24th St.
Wheeling: Wheeling Rubber Products Inc., 927 Market St.

ALLEGHENY LUDLUM STEEL CO., CARMET DIV.
1500 Jarvis Ave., Detroit, Mich., Jordan 4-6900

DISTRIBUTORS
ALABAMA
Birmingham: Birmingham Bolt Co., 724 Ave W—Ensley, ST 5-3154
ARKANSAS
Fort Smith: R. A. Young & Son, Inc., 301 South 10th, SU 3-8901
COLORADO
Denver: Union Supply Co., (5460 Colorado Blvd.) P.O. Box 6735 Stockyards Sta., AM 6-2292
ILLINOIS
West Frankfort: Coalfield Co., 329 East Main
Chicago: Goodman Mfg. Co., Halsted St. & 48th Place
Chicago: Vanguard Equip. & Supply Corp. 231 S. LaSalle St., FI 6-0331
INDIANA
Terre Haute: Gharst Supply Co., 550 N. 9th St., C-6733
IOWA
Des Moines: Peerless Supply Co., 2431 Dean Ave., AM 5-0333
KENTUCKY
Harlan: McComb Supply Co. Inc., phone—361
Madisonville: Mine Equipment & Supply Co., 149 Dempsey St., TA 1-2644
NEW MEXICO
Carlsbad: Bit Grinding Service, P. O. Box 803, TU 5-2436
OHIO
St. Clairsville: Oglebay Norton Co., Mine Supply Div., OX 5-3611 or 5-2902
Youngstown: Fairmonff Supply Co., 3705 Oakwood Ave., SW 9-1556
OKLAHOMA
Picher: Consolidated Supply Co., P.O. Box 367, Phone 840 and LD-5
McAlester: The Gladstein Co., 401-25 South Main St., GA 3-1307
PENNSYLVANIA
Pittsburgh: Somers, Fitler & Todd Co., 325 Fort Pitt Blvd., CO 1-4860
Portage: Oglebay Norton Co., Box 697, Beaverdale, Pa. 8-5338
Uniontown: Tri-State Mine Supply Co., 72 N. Gallatin Ave. GE 7-2786
Washington: Fairmont Supply Co., 437 Jefferson Ave., BA 2-5200
TENNESSEE
Jellico: McComb Supply Co., GA 4-8441
Whitewell: Marion Mine & Mill Supply Co.
UTAH
Price: Cate Carbon Equipment Co., P.O. Box 310 ME 7-2266 or ME 7-3346
VIRGINIA
Andover: Central Supply Co. of Virginia
WEST VIRGINIA
Bluefield: Bluefield Hardware Co., 400 Bluefield Ave., DA 7-5131
Bluefield: Fairmont Supply Co., Route 52, North, DA 5-6186
Charleston: Persingers, Inc. 520 Elizabeth St., DI 6-5341
Fairmont: Fairmont Supply Co., 10th St. and Beltline, phone 2110
Farmington: Oglebay Norton Co., Box 752, Farmington 3307
Shinnston: Erwin Supply Co., Pike Street Extension
Williamson: Persinger Supply Co., BE 5-1400
CANADA
Galt, Ontario: Joy Mfg. Co. (Canada) Ltd.
Calgary, Alberta: Joy Mfg. Co., (Canada) Ltd., 111 Third Avenue, E. phone 2-5205
Sydney, Nova Scotia: Joy Mfg. Co., (Canada) Ltd., 87 Charlotte St., Phone 6221

ALLIS-CHALMERS MFG. CO.
1126 S. 70th St., Milwaukee 1, Wis.

SALES OFFICES
ALABAMA
Birmingham 9, 1824-29th Ave. So., TR 9-8621
ARIZONA
Phoenix: 3300 N. Central Ave., Cr. 4-5426
COLORADO
Denver 3: 655 Broadway Bldg., Suite 205, CH 4-2951

GEORGIA
Atlanta 3: 57 Forsythe St., N.W., JA 2-7116
ILLINOIS
Chicago 3, 135 S. LaSalle St., FR 2-6480
Peoria 2: Commercial Natl. Bank Bldg., FR 4-9279
Rockford: 303 North Main St., WO 5-0664
INDIANA
Evansville 9: 329 Main St., HA 4-8219
Indianapolis 18: 3590 N. Meridan St., WA 4-5361
IOWA
Davenport: 326 W. Third St., WA 3-9793
Des Moines: 206 Sixth Ave., CH 3-8682
KANSAS
Wichita 2: 114 South Main Street, FO 3-9762
KENTUCKY
Louisville 8: 233 East Burnett Ave., ME 7-5478
MARYLAND
Baltimore 18: 1115 East 30th St., HO 7-4480
MICHIGAN
Detroit 35: 17170 W. Seven Mile Rd., BR 3-6400
Grand Rapids 2, 5-7 Lyon St., N.W., GL 9-8249
Jackson: 297 W. Michigan Ave., ST 4-8591
MISSOURI
Kansas City 8: 1734 Main St., VI 2-0132
St. Louis 5: 7912 Bonhomme Ave., PA 6-5454
NEBRASKA
Omaha 2: 14th & Farnam Sts., AT 1780
NEW MEXICO
Albuquerque: 5104 Grand Ave., N.E., AM 8-5064
NORTH CAROLINA
Charlotte 6: 300 E. Seventh St. ED 4-1667-8-9
OHIO
Akron 13: 2003 West Market St., TE 6-7996
Cincinnati 6: 1501 Madison Road, PL 1-6700
Cleveland 14: 1717 East Ninth St., MA 1-5182
Columbus 12: 1500 W. Third St., HU 6-2465
Dayton 2: 11 W. Monument Ave., BA 8-2174
Toledo 4: 245 Summit St., CH 4-7488
Youngstown 3: 25 Boardman St., RI 3-5175
OKLAHOMA
Oklahoma City 1: 401 N. Harvey, RE 9-1631
Tulsa 3, 320 E. Archer St., GI 7-9163
OREGON
Portland 22: 2300 S.E. Beta St., OL 4-9527
PENNSYLVANIA
Allentown: 1436 Hamilton St., HE 4-9366
Philadelphia 3: 1617 Pa. Blvd., LO 3-8412
Pittsburgh 16: 1701 McFarland Road, LO 3-4434
York: 56 North Queen Street, YO 5415
TENNESSEE
Chattanooga 2: Hamilton Natl. Bank Bldg., AM 6-5101
Knoxville 2: 531 S. Gay St., AM 2-2165
Memphis 3: 46 N. Third St., JA 7-0377
UTAH
Salt Lake City 1: 136 S. Main St., EM 3-1723
VIRGINIA
Richmond 19, 3311 W. Broad St., EL 8-3851
WASHINGTON
Seattle 1, 1325 4th Ave., MA 4-3737
Spokane 17: West 12 Indiana Ave., FA 7-1581
WEST VIRGINIA
Charleston 1: 179 Summers St., DI 3-9505
CANADA
Calgary, Alberta: 709-8th Ave. W, AM 2-5880
Edmonton, Alberta: 10304 103rd St., GA 2-4013
Fredericton, New Brunswick: P.O. Box 505, GR 1-2622
Halifax, Nova Scotia: 353 Bayers Rd., 455-2130
Montreal, Quebec: 3333 Cavendish Boulevarrd, HU 9-8271
Ottawa, Ontario: 864 Lady Ellen Place, PA 9-5482
Port Arthur, Ont.: 12-A Court St. S, PA 5-7632
Regina, Saskatchewan: P.O. Drawer 258, LA 2-5616
Sherbrooke, Quebec: P.O. Box 385, LO 2-6130
Toronto, Ontario: Post Office Box 280, Adelaide Street P.O. EM 4-0486
Vancouver, B.C.: 1200 W. Pender St., MU 1-3496
Winnipeg, Manitoba: 862 Dufferin, Ave., JU 9-5373

ALLISON D'V., GENERAL MOTORS CORP.
Indianapolis 6, Ind.

DISTRICT SALES OFFICES
PENNSYLVANIA
Monroeville: C. S. Sherrill, 525 Larix Rd., Drexel 3-0389

DISTRIBUTORS
ILLINOIS
Broadview: Western Engine Co., 2625 W. 16th St., Murray 1-2600 Estebrook 8-8644
MISSOURI
Kansas City: K C Diesel Power Co., 1711 Swift Ave., P. O. Box 7361, Grand 1-3526
St. Louis 32: Western Diesel Engine Co., 1441 N. Warson Rd., HA 9-2131
WEST VIRGINIA
So. Charleston: Ray C. Call, Inc., P. O. Box 8245, Poplar 8-1253

AMERICAN BILTRITE RUBBER CO., INC.
BOSTON WOVEN HOSE & RUBBER DIV.
P. O. Box 1071, Boston 3, Mass.

DISTRICT SALES OFFICES
ALABAMA
Birmingham: P.O. Box 1816, Tremont 9-9644
COLORADO
Denver: 710 West Colfax Ave., Alpine 5-3756
GEORGIA
Decatur: 3508 Woods Drive, BU 9-2516
ILLINOIS
Broadview: 2651 Gardner Rd., Fillmore 5-0320
INDIANA
Bloomington: P. O. Box 801, Edison 6-4421
KANSAS
Shawnee Mission: 5225 Mohawk Drive Skyline 1-1018
MINNESOTA
Minneapolis 2: 1002 Baker Bldg., Federal 9-5893
St Louis 9: 3351 Lawn Ave., FI 1-8977
OHIO
Cleveland 30: 7586 Webster Rd., Berea 4-3078

DISTRIBUTORS
ALABAMA
Birmingham: Dixon Supply Co., 3104 4th Ave., South
Decatur: H & H Supply Co., 158 First Ave.
COLORADO
Denver: Midwest Rubber & Supply Co., 710 West Colfax Ave.
GEORGIA
Atlanta: Industrial Service Co., P. O. Box 13555, Station K
ILLINOIS
LaGrange Park: Gooding Rubber Co., 806 E. 31st St.
INDIANA
Evansville: Housh Industrial Supplies, 30 Main St.
Indianapolis: Indianapolis Belting & Supply Co. 212 S. Capitol Avenue
Richmond: Queen City Supply Co.
KENTUCKY
Lexington: Industrial Division, Womwell Automotive Parts Co., Inc. 240 Clark St.
Louisville: Henderson Rubber Co., 1010 Clarks Lane
MISSOURI
St. Louis: Te-Co, Inc. 801 North Second Street
OHIO
Cincinnati 37: Queen City Supply Co., 7676 Rienhold Drive
PENNSYLVANIA
Pittsburgh: Boston Woven Hose & Rubber Co. of Pittsburgh, Box 895, Fort Pitt Blvd.
TENNESSEE
Chattanooga: Rogers-Bailey Supply Co., 1146 Market St.
Knoxville: Browning Belting & Supply Co., Inc. 205 North Central
Memphis: Industrial Supplies, Inc. Poplar Avenue and River Front
UTAH
Salt Lake City 10: Mountain States Rubber Co., 131 Social Hall Ave.
WEST VIRGINIA
Bluefield: Bluefield Supply Co.

AMERICAN BRAKE SHOE CO., AMERICAN MANGANESE STEEL DIV.
389 E. 14th St., Chicago Heights, Ill.

DISTRICT SALES OFFICES
Delaware
New Castle: EA 8-7513
ILLINOIS
Chicago Heights: 389 E. 14th St., SKyline 4-2200
MISSOURI
St. Louis: 6600 Ridge Ave., EVergreen 5-6472
PENNSYLVANIA
Pittsburgh: 717 Grant Bldg., GRant 1-3023

AMERICAN BRATTICE CLOTH CORP.
King's Highway, Warsaw, Inc.

DISTRICT SALES OFFICE
OHIO
Cleveland: 1313 W. 11th St.
PENNSYLVANIA
Pittsburgh: One Cedar Boulevard

AMERICAN CHAIN & CABLE CO., INC.
Wilkes-Barre, Pa.

DISTRICT SALES OFFICES
GEORGIA
Atlanta: 1055 W. Marietta St., N. W., Sycamore 4-8226
ILLINOIS
Chicago: 2040 B, Gawthorne Ave., Estebrook 8-2404 (Chicago) Fillmore 5-6600 (Melrose Park)
PENNSYLVANIA
Philadelphia 25: Second and Diamond Sts., Regent 9-7460
Pittsburgh 5: 2250 Noblestown Rd., Walnut 2-2100

AMERICAN CYANAMID CO. EXPLOSIVES AND MINING CHEMICALS DEPT.
Bound Brook, N.J.

DISTRICT SALES OFFICES
ALABAMA
Bessemer: Hamilton 5-2144
MASSACHUSETTS
Maynard: Box 5, Twinoaks 7-2811
MISSOURI
Kansas City: 6100 East 60th St., Emerson 3-3305
St. Louis: P.O. Box 251, Mohawk 4-5306
NEW JERSEY
Bound Brook: Elliot 6-2000
PENNSYLVANIA
Latrobe: P.O. Box 270. Keystone 7-5571
Pottsville: 304 West Market St. Market 2-1303
UTAH
Salt Lake City: 515 Walker Bank Bldg., Davis 8-0651
WEST VIRGINIA
Bluefield: P.O. Box 4395. Davenport 7-7316

AMERICAN MINE DOOR CO.
2057 Dueber Ave. S.W. Canton 6, Ohio, Glendale 4-7055

DISTRIBUTORS
ALABAMA
Birmingham 5: J. L. Thomas, 429 S. 24th St., FA 4-7032
ARIZONA
Phoenix: National Equipment Co., 35 E. Pierson St., AM 5-0019
COLORADO
Denver 7: Ralph B. Moore, Inc., 3847 Forest St., Cherry 4-2969
INDIANA
Vincennes: Oren R. Gulley, 1648 N. 13th St., 1183
MICHIGAN
Ishpeming: Charter Inc., 115 S. 1st St., Hudson 6-4471
NEW MEXICO
Albuquerque: National Equipment Co., 1404 Martha N.E. AX 9-4161
PENNSYLVANIA
Hazleton: Barrett Haentjens Sales Co., 225 North Cedar St., GL 4-0837
UTAH
Salt Lake City: National Equipment Co., 1020 South Sixth West, Empire 3-8878
WASHINGTON
Spokane 67: National Equipment Co., 311 N. Adams Rd., WA 4-2930

AMERICAN STEEL & WIRE DIV., U. S. STEEL CO.
Rockefeller Bldg., Cleveland, Ohio

ANACONDA WIRE & CABLE CO.
25 Broadway, New York 4, N.Y.

ATLAS POWDER CO.
Wilmington 99, Del.

DISTRICT SALES OFFICES
ILLINOIS
Chicago: 1606 Feld Bldg., 135 S. LaSalle St., Franklin 2-9530
Missouri
Joplin: 612 First National Bldg., Mayfair 4-924
PENNSYLVANIA
Pittsburgh: 1544 Oliver Bldg., Atlantic 1-2684
Tamaqua: 601 Schuykill Ave., Phone 1300
Wilkes-Barre: 1026 Miners Bank Bldg., Valley 3-2516
TENNESSEE
Knoxville: 813 Hamilton National Bank Bldg., Phone 2-2147
WASHINGTON
Seattle: 1320 Joseph Vance Bldg., Main 2-5110

DISTRIBUTORS
ILLINOIS
Lenzburg: Superior Explosives Co., Phone New Athens, Ill., 215
Marion: Superior Explosives Co., Mr. Ed Cash, 511 E. Main St., Phone 834
Quincy: Quincy Supply Co., 700 S. Front St., Baldwin 3-1171
INDIANA
Brazil: Hoosier Explosives Co., 26-28 S. Walnut St., Phone 2391
New Albany: C. L. Graf, Inc., 431 Pearl St., Whitehall 4-1113
KENTUCKY
Barbourville: Blair-Noonan Co.
Prestonburg: Prestonburg Explosive Co., Phone 2345
OHIO
Berlin: Yoder Hybrid Corn Co.
Canton: Apex Powder Corp., 1545 Waynesburg Rd., S. E.
Oak Hill: Oak Hill Powder Sup.
PENNSYLVANIA
Brockway: Beadle Corp.
Clarion: Amos L. Dolby
Clymer: Longwill Mine Supply Co., 56 Morris St.
Listie: Edward Steinkirchner
Meyersdale: Shipley Hardware Co.
Philipsburg: John F. Mitchell Cold Stream
Ramey: Williams Powder Co.
Sidman: George H. Miller
Six-Mile Run: Ralph M. Shuke
Tyler: Patsy Georgino & Son
Uniontown: George F. Buerger, 656 Bierer Lane
TENNESSEE
Chattanooga: Mill & Mine Supply Co.
La Follette: Card Explosives Co., Phone 85
Pikeville: Four Way Store, Gilbert 7-5710
S. Pittsburg: Paul's Food Market, Temple 7-7551
Whitewell: Marion Mine & Mill Supply Co., Wholesale Co.
VIRGINIA
Big Rock: Buchanan
Grundy: Bevins-Atlas Co., P. O. Box 1168
Norton: Witaker-Atlas Supply Co. Phone 1263
WASHINGTON
Seattle: Carrington Co., 91 Columbia St.
WEST VIRGINIA
Beckley: West Virginia Explosives Co., Cl 2-7061
Bluefield: Bluefield Hardware Co., 400 Bluefield Ave.
Bluefield Supply Co., 100 Mercer St., Phone 6121
Enterprise Trucking Co., Davenport 7-2361
Clarksburg: Atlas Supply & Equip Co., Inc., 309 N. Fourth St.
Charleston: W. Virginia Explosive Co., Riverside 4-5521
East Rainelle: Greenbrier Explosive Co., He 8-7171
Lewisburg: Midland Explosives & Equip. Co.
Sutton: A. L. Rose & Co.

AUSTIN POWDER CO.
4805 Clinton Pike, N.W., Knoxville, Tenn.

DISTRICT SALES OFFICE

INDIANA
Evansville: 2029 Washington Ave., GR 7-5373

KENTUCKY,
Hazard: 668 Broadway, GE 6-3723
Madisonville: 39 Federal St., Taylor 1-5340

PENNSYLVANIA
Scranton: 148 Adams Ave., DI 0169
Waynesburg: P. O. Box 388, phone—1324

VIRGINIA
Grundy: WE 5-2369
Norton: phone—105

WEST VIRGINIA
Huntington: 1218 Fifth Ave., Jackson 2-3751
Matewan: HA 6-4731
Mount Hope: TR 7-2301

DISTRIBUTORS

KENTUCKY
Jackson: Jackson Wholesale, P.O. Box 634, NO 6-2285
Sand Gap: Little Brothers, WE 5-2551
West Liberty: Licking River Limestone Co., SH 3-4575
Whitesburg: Clyde Lucas, P.O. Box 186, phone—2606

PENNSYLVANIA
Berlin: I. A. Engleka, 1400 East Main St., phone—3438
Clearfield: Dufton Hardware, phone—5-6575
Kittanning: Ringgold Corp., Liberty 3-0021
New Bethlehem: Cribbs Hardware, 238 Broad St., BR 5-8234
Philipsburg: Kephart Hardware Co. P.O. Box 75, DI 2-3080
Six Mile Run: M. H. McMillin, P.O. Box 85, Hopewell 928—2703
Troy: P. S. King Hardware Co., P.O. Box 35, AX 7-3445
Windber: Nelson's Store, phone-521-J

TENNESSEE
La Follette: Powell Valley Hardware, phone—75
Livingston: Marcom Explosive Co., Jackson 6-4961
South Pittsburg: J. A. Payne, Temple 7-6076

VIRGINIA
Grundy: C. S. Schubert, WE 5-2369

WEST VIRGINIA
Belington: Kanue & Keyser Hardware Co., phone—2461
Buckhannon: A. G. Shannon Hardware Co., phone—1600
Chapmanville: Tom Wilding, UL 5-4521
Coaldale: C. W. Blizzard, CH 8-3225
Elkins: Valley Supply Co.
Mason: Lieving Coal Co., Spruce 3-5593
Masontown: A. De Prospero, Jr., UN 4-2181
Matewan: Willis Smith, HA 6-4731
Mount Hope: Joe Trail, TR 7-2301

B

BARBER-GREENE CO.
400 N. Highland Ave., Aurora, Ill.

DISTRICT SALES OFFICES

ALABAMA
Birmingham 2: Barber-Greene Co., Room 216, 512 N. 18th St.

ILLINOIS
Chicago 6: Barber-Greene Co., 9 S. Clinton St.

TEXAS
Dallas 6: Barber-Greene Co., 4515 Prentice St.

DISTRIBUTORS

ARKANSAS
Fort Smith: R. A. Young & Son, Inc., 301 S. Tenth St.
Little Rock: R. A. Young & Son, Inc., 5th & Rector, P. O. Box 2197

COLORADO
Denver 16: Booth-Rouse Equipt. Co., 5700 Eudora

INDIANA
Evansville: Brandeis Machinery & Supply Corp., U. S. Highway 41, North at Diamond Ave.
Terre Haute: J. B. Freeman Co., P. O. Box 223

IOWA
Cedar Rapids: Hawkeye Machinery Co., Highway 30—149
Des Moines 9: Hawkeye Machinery Co., 1225 Walnut St.

KENTUCKY
Louisville 1: Brandeis Machinery & Supply Corp., Brook & Warnock Sts., P. O. Box 1705
Middlesboro: Brandeis Machinery & Supply Corp., N. 19th St., P. O. Box 515
Paducah: Brandeis Machinery & Supply Corp., P. O. Box 906

MARYLAND
Elkridge 27: The Henry H. Meyer Co., Inc., 5325-27 Main St.

MISSOURI
Kansas City 8: Funkhouser Machinery Co., 2425 Jefferson St.
St. Louis 8: Allied Construction Equip. Co., 4015 Forest Park Ave.
St. Louis 2: Harold L. Emerson, 319 North 4th St.

MONTANA
Billings: Western Construction Equip. Co., 505 N. 24th St., P. O. 2537
Great Falls: Western Construction Equipt. Co., Great Falls Div., 2322 River Drive, P. O. Box 1504

NORTH DAKOTA
Bismarck: Sweeney Brothers Tractor Co., Highway 83 North
Fargo: Sweeney Brothers Tractor Co., 1622 Main Ave., P. O. Box 1468

OHIO
Cincinnati 14: Rish Equipment Co., 1212 Dalton Ave., P. O. Box 120
Cleveland 14: The McLean Co., 3525 Lakeside Ave.
Columbus: The McLean Co., Room 216, 580 E. Town St.

OKLAHOMA
Oklahoma City: Butler-Sparks Equipment Co., 1704 N. W. 6th St., P. O. Box 675
Tulsa: Butler-Sparks Equipment Co., 202 S. Lansing

OREGON
Portland 9: Clyde Equipt. Co., 1631 N. W. Thurman St.

PENNSYLVANIA
Philadelphia 2: A. R. Amos Co., 713 Commercial Trust Bldg.
Pittsburgh 8: G. N. Crawford Equipment Co., 6714 Kelly St., P. O. Box 5781

SOUTH DAKOTA
Rapid City: Rapid Equipment Co., 605 Steele Ave., P. O. Box 506

TENNESSEE
Knoxville 18: Story Bros., Inc., 4130 Clinton Highway
Chattanooga 4: Story Brothers, Inc., 919 Dodds Ave., P. O. Box 3068
Memphis 5: Priester Machinery Co., Inc., 249 S. 3rd St., P. O. Box 310
Nashville 4: McCarthy, Jones & Woodard, 723 Argyle Ave., P. O. Box 9068

UTAH
Salt Lake City 10: Atlas Equipment Co., 2525 S. 2nd West, P. O. Box 26

VIRGINIA
Coeburn: Rish Equipment Co., W. Main St.
Richmond 10: Rish Equipment Co., 1601 Chamberlayne Ave., P. O. Box 1260
Roanoke 7: Rish Equipment Co., 405 Center Ave., N. W., P. O. Box 1369

WASHINGTON
Seattle 4: The Carrington Co., 91 Columbia St.
Seattle 4: A. H. Cox & Co., 1757 First Ave. S.
Spokane: Inland Diesel & Machinery Co., P. O. Box 2169, 3511 E. Trent Ave.

WEST VIRGINIA
Bluefield: Rish Equipment Co., 100 Mercer St., P. O. Box 269
Bluefield: Rish Equipment Co., North on U. S. 52, P. O. Box 1261
Clarksburg: Rish Equipment Co., East on U. S. Route 50, P. O. Box 2227
Charleston 22: Rish Equipment Co., P. O. Box 353
Parkersburg: Rish Equipment Co., 140 19th St., P. O. Box 1728

WYOMING
Casper: Keremi Tractor & Equipt. Co., North on Hwy. 87, P. O. Box 519
Cheyenne: Keremi Tractor & Equipment Co 703 W. 17th St., P. O. Box 908

BETHLEHEM STEEL CO.
Bethlehem, Pa.

DISTRICT SALES OFFICES

GEORGIA
Atlanta 1: J. E. McQueen, 1312 Fulton National Bank Bldg., 55 Marietta St.

ILLINOIS
Chicago 1: E. H. Gumbart, 2700 Prudential Bldg., Prudential Plaza
Herrin: Hugh S. Dawson, 500 W. Monroe St.

MARYLAND
Baltimore 3: S. C. Husted, 1600 Commercial Credit Bldg., 300 St. Paul Place

OHIO
Cincinnati 2: O. W. Buenting, 1401 Fifth Third Bank Bldg., 4th & Walnut Sts.
Cleveland 13: F. W. West, Jr., 2700 Terminal Tower, 50 Public Square

PENNSYLVANIA
Bethlehem: J. D. Mixsell, Rex. Repr., Bethlehem Trust Bldg., Broad & Main Sts.
Johnstown: L. M. Donnelly, Res. Repr., Bethlehem Bldg., 119 Walnut St.
Philadelphia 3: R. S. Taylor, 1058 Suburban Sta. Bldg., 1617 Penn. Blvd.
Pittsburgh 22: R. T. Eaton, 1200 Oliver Bldg., Mellon Square
Wilkes-Barre: A. B. Ramsey, Box 1241

TENNESSEE
Knoxville: J. Watkins, Jr., Box 1229, 8213 Chesterfield Drive

UTAH
Salt Lake City 11: L. B. Gillette, Executive Bldg., 455 E. 4th South

WEST VIRGINIA
Bluefield: E. W. Outten, 2415 Bland Rd.
Charleston: L. R. Schoffstall, 909 Chappel Rd., S.E.

BIRD MACHINE CO.
South Walpole Mass., Montrose 8-0400

DISTRICT SALES OFFICES

GEORGIA
Atlanta 9: 1430 West Peachtree St., N. W.

ILLINOIS
Evanston: 603 Main St.

WEST VIRGINIA
Huntington: 438 13th Ave.

CALIFORNIA
Walnut Creek: 1766 Locust Street

BIXBY-ZIMMER ENGINEERING CO.
961 Abingdon St., Galesburg, Ill.

BOWDIL CO., THE
Boylan Ave. S.E., Canton 7, Ohio, Glendale 6-7176

DISTRICT SALES OFFICES

COLORADO
Denver: Wm. Radcliff, 761 Steele St., EA 2-7151

ILLINOIS
West Frankford: Randal A. Leach, 1004 E. St. Louis St., Phone 675

KENTUCKY
Whitesburg: A. J. Leach, Sand Lick Rd. Phone 2232

OHIO
Magnolia: C. W. Weis-Burn. UN 6-2166

PENNSYLVANIA
Perryopolis: J. M. Blasco, North Liberty Ave., Redfield 6-2575

WEST VIRGINIA
Danville: E. D. Caudill, Box 132, Phone 810

UTAH
Helper: V. L. Waldington, Phone 144

CANADA
Drumheller, Alberta: Webb Distributors, Ltd.

BRODERICK & BASCOM ROPE CO.
4203 Union Blvd., St. Louis, 15, Mo.

DISTRICT SALES OFFICES

GEORGIA
Atlanta 10: Broderick & Bascom Rope Co., 680 Murphy Ave., SW

ILLIONIS
Melrose Park: Broderick & Bascom Rope Co., 2045 N. 15th Ave.

DISTRIBUTORS

COLORADO
Denver: Mine and Smelter Supply Co., 3800 Race St.

KENTUCKY
Harlan: Kentucky Mine Supply Co.

OHIO
Youngstown 12: Mahoning Valley Supply Co., 704 Youngstown-Poland Rd.

BUCYRUS-ERIE CO.
So. Milwaukee, Wisc.

DISTRICT SALES OFFICES

CALIFORNIA
So. San Francisco: 120 Freeway St., P. O. Box 626

GEORGIA
Atlanta 3: 1508 William-Oliver Bldg.

ILLINOIS
Chicago 3: Room 3100, 105 W. Adams St.

NEW YORK
New York 20: 1 Rockefeller Plaza

WISCONSIN
So. Milwaukee: P. O. Box 56

BUELL ENGINEERING CO., INC.
123 William St., New York 38, N. Y., Cortlandt 7-0900

SALES AGENTS

COLORADO
Denver 11: Contract Engineering, 1727 Boulder St., GE 3-3356
Denver 14: Patten Engineering, 1795 Sheridan, BE 7-0433

GEORGIA
Atlanta 5: E. L. Shuff & Assoc., Suite 122-124, 3120 Maple Drive, N.E. CE 7-9215

ILLINOIS
Chicago 2: D. H. Skeen & Co., 1 North LaSalle St., ST 2-1415
Chicago 5: V. E. Winfield & Associates, 407 South Dearborn St., WE 9-0648

INDIANA
Indianapolis 20: M. S. Nelson, 6216 Carrollton Ave., CL 1-6156

MARYLAND
Baltimore: Jobe & Co., 2857 Greenmount Ave., BE 5-3502

MISSOURI
Kansas City 12: Midwestern Power Equipment, 1214 West 47th St., VA 1-7507

NEW YORK
Rochester 1: Buckpitt & Co., P. O. Box 292, BA 5-8300

OHIO
Akron 9: B. W. Rogers Co., 380 Water St., PO 2-0251
Columbus 12: Lazear Equipment Co., 867 King Ave., AX 4-5407

PENNSYLVANIA
Havertown: Dorn Industrial Equipment, 1262 Chester Pike, SU 9-4895
Philadelphia 3: Stewart Miller Co., 605 Fox-Philadelphia Bldg., LO 7-5003
Pittsburgh 19: D. D. Foster Company, 2210 Koppers Bldg., AT 1-0864
Pittsburgh 22: Mann Engineering Co., 805 Bessemer Bldg., AT 1-2950

TENNESSEE
Memphis 3: Engineered Plant Equipment, 22 South 2nd St., JA 6-6232

C

CARRIER CONVEYOR CORP.
254-A N. Jackson St., Louisville, Ky.

CATERPILLAR TRACTOR CO.
Peoria, Ill.

DISTRIBUTORS

ALABAMA
Birmingham: Thompson Tractor Co., Inc. P. O. Box 2642

ARKANSAS
Little Rock: J. A. Riggs Tractor Company P. O. Box 1399

COLORADO
Denver: McCoy Company P. O. Box 5188—Terminal Annex

ILLINOIS
Bellwood: Patten Tractor & Equipment Co. 620 South 25th Avenue
Peoria: Peoria Tractor & Equipment Co. 2319 E. War Memorial Drive
Springfield: Witt - Armstrong Equipment Co. P. O. Box 2008

INDIANA
Indianapolis: MacAllister Machinery Co., Inc. 2118 North Gale Street

IOWA
Cedar Rapids: Altorfer Machinery Company 2600 6th St., S.W.

KANSAS
Topeka: Martin Tractor Company, Inc. P. O. Box 237

KENTUCKY
Louisville: Whayne Supply Company P. O. Box 1737
MARYLAND
Baltimore: Alban Tractor Co., Inc. P. O. Box 56
MISSOURI
Joplin: E. A. Martin Machinery Co. P. O. Box 1111
Kansas City: Dean-Hanes Machinery Co. Box 1176
St. Louis: John Fabick Tractor Company 3100 Gravois Avenue
NEW MEXICO
Albuquerque: Rust Tractor Co. P. O. Box 1320
NORTH DAKOTA
Bismarck: Schultz Machinery Co. P. O. Box 868
OHIO
Cleveland: Ohio Machinery Co. 6606 Schaaf Road
Columbus: Central Ohio Tractor Co. 3765 East Livingston Avenue
PENNSYLVANIA
Harrisburg: Cleveland Brothers Equipment Co., Inc. P. O. Box 62
Pittsburgh: Beckwith Machinery Co. P. O. Box 8718
OKLAHOMA
Tulsa: Albert & Harlow, Inc. P. O. Box 15800 Admiral Station
TENNESSEE
Knoxville: Stowers Machinery Corporation P. O. Box 9099
TEXAS
Corpus Christi: B. D. Holt Co. P. O. Box 1979
VIRGINIA
Roanoke: Carter Machinery Company, Inc. P. O. Box 929
WASHINGTON
Seattle: Northern Commercial Company 4233 West Marginal Way
WEST VIRGINIA
Charleston: Walker Machinery Co. Route 60 East, P. O. Box 2427
WYOMING
Cheyenne: Wortham Machinery Company P. O. Box 893

CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.
146 President St., St. Louis 18, Mo., PR 6-2848

DISTRICT SALES OFFICE
PENNSYLVANIA
Irwin: 49 Woodall Ave., Un 3-3228
WEST VIRGINIA
Huntington: 925 6th Ave., Jackson 9-4131

CHEATHAM ELECTRIC SWITCHING DEVICE CO.
4780 Crittenden Dr., Louisville 9, Ky., Emerson 3-3571

SALES OFFICES
UTAH
Salt Lake City 15: 18 East Stratford Ave. IN 7-5997

CHICAGO PNEUMATIC TOOL CO.
6 East 44th St., New York 17, New York
ALABAMA
Birmingham 4: 810 Fifth Ave., No.
COLORADO
Denver 4: 465 Acoma St.
GEORGIA
Atlanta 9: 91-16th St., N.W.
ILLINOIS
Chicago 19: 936 East 87th St.
MICHIGAN
Detroit 26: 570 East Larned St.
MISSOURI
St. Louis 17: 8029 Litzsinger Rd.
PENNSYLVANIA
Pittsburgh: 369 Coltart Ave.

DISTRIBUTORS
ILLINOIS
Peoria: Dooley Bros., 1201 S. Washington St.
INDIANA
Evansville 5: Austin Powder Co., 616 N.W. 2nd St.
Terre Haute: Advance Electrical Co., 545 N. 6th St.
Terre Haute: Mine Supply Co., 417 N. 13th St.
KENTUCKY
Harlan: Kentucky Mine Supply Co.
Harlan: McComb Supply Co.
Lothair: Mine Supply Co.
PENNSYLVANIA
Johnstown: M. Glosser & Sons, Inc., 72 Messenger St.
Johnstown: Penn Machine Co.
Scranton 9: L. A. Harding Co. 1625 Nay Aug Ave.
TENNESSEE
Jellico: McComb Supply Co.

UTAH
Salt Lake City 1: 146 West Fourth South
VIRGINIA
Grundy: Buchan-Willimson Supply Co.
McClure: Erwin Supply & Hardware Co.
WEST VIRGINIA
Charleston 27: Persingers, Inc., P. O. Box 1866
Fairmont: Fairmont Supply Co., 10th & Belt Line
Huntington: Ensign Electric & Mfg. Co., 914 Adams Ave.
Williamson: Persingers Supply Co.
Williamson: Williamson Supply Co.

CIRCLE WIRE & CABLE CORP.,
Subsidiary of CERRO CORPORATION, 550 Maspeth Avenue, Maspeth, New York. Evergreen 6-5500

SALES OFFICE & WAREHOUSE
COLORADO
Denver: 211 Wazee Street, Acoman 2-4893
MARYLAND
Baltimore: Burg & Ellen, 526 E. Monument St., Mulberry 5-3633
MISSOURI
St. Louis 8: Gene Hagen & Company, 4232 Forest Park, Olive 2-1036
NEW MEXICO
Albuquerque: Sales Engineers, Inc. 721 Loma Vista Drive, Alpine 5-9625
OHIO
Cincinnati: Block & Cooper, 1050 Meta Drive, Redwood 1-2196
PENNSYLVANIA
Philadelphia: 923 Locust Street, Center 6-0121
Pittsburgh: H. W. Groetzinger & Co., 410 E. Gen'l. Robinson St., Alleghany 1-6280

COLUMBUS McKINNON CORP., MINING EQUIPMENT DIV.
52 Fremont Ave., Tonawanda, N.Y.

DISTRIBUTORS
ALABAMA
Birmingham 5: J. O. Thomas Co., 429 S. 24th St., FA 4-7032
ILLINOIS
Chicago 4: J. Schonthal & Assoc., Inc. 224 S. Michigan Ave., WA 2-8350
NEW MEXICO
Carlsbad: Carlsbad Supply Co., 501 Park Drive, P. O. Box 1042, Tuxcedo 5-3636
PENNSYLVANIA
McKees Rocks: Schroeder Bros. Corp., Nichol Ave., Box 72 SP 4810
UTAH
Salt Lake City: National Equipment Co., P. O. Box 1767

CONNELLSVILLE CORP.
Connellsville, Pa.

SALES AGENTS
ALABAMA
Birmingham 5: Ebbert & Kirkman Co., Inc., 720 S. 23rd St., Alpine 1-9174

D

DAVEY COMPRESSOR CO.
600 Franklin Ave., Kent, Ohio

DISTRIBUTORS
ALABAMA
Birmingham: Blackwell McFarland Euclid Co., Inc., P.O. Box 6530
ARIZONA
Phoenix: Superior Equipment Co., P.O. Box 6325
GEORGIA
Atlanta: Statham Machinery & Equip. Co., 671 Ford Place N.E.
KENTUCKY
Lexington: Contractors Equipment Co., 780 East Third St.
MARYLAND
Timonium: S. M. Christhilf & Son, Timonium Rd & Harrisburg Expressway
NORTH CAROLINA
Raleigh: J. B. Hunt & Sons, Inc., 323 W. Martin St.
PENNSYLVANIA
Frostburg: Stockdate Mine Supply Co.

DEISTER CONCENTRATOR CO., INC.
909 Glasgow Ave., Fort Wayne, Ind.

DISTRICT SALES OFFICES
ALABAMA
Birmingham: 2612 N. 24th St.
PENNSYLVANIA
Nesquehoning: 35 E. Center St.

DETROIT DIESEL ENGINE DIV., GENERAL MOTORS CORP.
13400 W. Outer Drive, Detroit 28, Mich., Kenwood 1-7100

DISTRICT SALES OFFICES
GEORGIA
Atlanta 5: Detroit Diesel Engine Div., General Motors Corp., 359 E. Paces Ferry Rd., N. E., Cedar 7-8666
ILLINOIS
Chicago 6: Detroit Diesel Engine Div., General Motors Corp., 110 N. Wacker Dr., Andover 3-7337
MICHIGAN
Wayne: Detroit Diesel Engine Div., General Motors Corp., 36501 Van Born Rd., Parkway 1-1000
NEW YORK
New York 19: Detroit Diesel Engine Div., General Motors Corp., 1320 Coliseum Office Bldg., 10 Columbus Circle, Plaza 7-4000

DISTRIBUTORS AND DEALERS
ALABAMA
Birmingham: Armstrong Equipment Co., 4601 First Ave., N., Worth 1-2134
GEORGIA
Atlanta 15: Dixie Engine Co., 3899 Tuskegee Ave., S. W., Poplar 1-3148
Atlanta: Blalock Machy. & Equip. Co., Inc., 225 Forsyth St., S. W., Jackson 1-0181
ILLINOIS
Broadview: Western Engine Co., 2625 W. 16th St., Mu. 1-2600
Mt. Carmel: Western Services, Inc., State Hwy. 15 West, 1380
KENTUCKY
Ashland: The Barney Williams Co., Inc., 207 14th St., 34-42195
Lexington: Bogie Equipment Co., 801 E. Third St., 2-3463-4
Louisville: Bogie Equipment Co., 4397 Poplar Level Rd., Gi. 8-3259
Madisonville: Bogie Equipment Co., U. S. Hwy. 41 North, Ta. 1-3468
MISSOURI
St. Louis 32: Western Diesel Engine Co., 1441 N. Warson Rd., Harrison 9-2131
OHIO
Cincinnati 15: Tri-State Engine Services, Inc., 10520 Chester Rd., Woodlawn, Princeton 1-2200
Columbus: Columbus Equipment Co., 50 E. Kingston Ave., Hi. 3-6541
Steubenville: Ray C. Call, Inc., 4030 Sunset Blvd. Ext., Amherst 4-1881
Strasburg: Gateway Diesel, Inc., 301 S. Wooster Ave., 4511
PENNSYLVANIA
Bedford: C. Duff GM Diesel Engine & Equip. Co., Inc., Route 220
Bloomsburg: General Sales, Inc., Sterling 4-1514
Harrisburg: Engines, Inc., 1500 Paxton St., Cedar 8-0471
Kingston: Standard Equipment Co., 340-344 Pierce St., Butler 8-1426
Philadelphia: Engines, Inc., 4152 E. Thompson St., Pioneer 3-3204
Phillipsburg: Capitol Equipment Co., Inc., Route 322, Dickens 2-4663
Wexford: Keystone Diesel Engine Co., Inc., Route 19, Westmore 5-1511
TENNESSEE
Chattanooga 1: Tennessee Diesel Services Div. of Nixon Machy. & Supply Co., Inc., 1300 Carter St., Amherst 7-5573
Knoxville: Tenn. Diesel Services Div. of Nixon Machy. & Supply Co., Inc., 4717 Clinton Hwy., Mu. 7-1601
Nashville: Tenn. Diesel Services Div. of Nixon Machy. & Supply Co., Inc., 1211 Demonbreum St., Alpine 5-5688
WEST VIRGINIA
So. Charleston: Ray C. Call, Inc., McCorkle Ave., Poplar 8-1253
So. Fairmont: Ray C. Call, Inc., Route 19, 4808

DIFFERENTIAL STEEL CAR CO.
Findlay, Ohio

DORR-OLIVER, INC.
Stamford, Connecticut

DISTRICT SALES OFFICES
GEORGIA
Atlanta: 3179 Peachtree Rd., N.E.
ILLINOIS
Chicago 54: 813 Merchandise Mart.
OHIO
Cleveland 7: 14700 Detroit Ave., P. O. Box 2663

DOWELL DIV., DOW CHEMICAL CO.
1918 Highway 41 North, Evansville 7, Ind.
WEST VIRGINIA
St. Albans: 197 Monterey Dr.

DRAVO CORP.
Neville Island, Pittsburgh 25, Pa.

DU PONT DE NEMOURS & CO., E. I., ELASTOMER CHEMICALS DEPT.
Wilmington 98, Del.

DISTRICT SALES OFFICES
CALIFORNIA
Los Angeles 58: 2930 E. 44 St., Ludlow 2-6464
Palo Alto: 701 Welch Rd., Davenport 6-7550
GEORGIA
Atlanta 3: 1261 Spring St., N. W., Trinity 5-5391
ILLINOIS
Chicago 3: 7 S. Dearborn St., Andover 3-7000
NORTH CAROLINA
Charlotte 1: 427 W. Fourth St., Franklin 5-5561
OHIO
Akron 8: 40 E. Buchtel Ave., Portage 2-8461
CANADA
Montreal: Du Pont of Canada, Ltd., P. O. Box 660, University 6-6461
Toronto: Du Pont of Canada Ltd., 85 Eglinton Ave., East, Hudson 1-6461

DU PONT DE NEMOURS & CO., E. I., EXPLOSIVES DEPT.
Wilmington 98, Delaware

DISTRICT SALES OFFICES
ALABAMA
Birmingham 13: 9 Office Park, Mountain Brook, TR 9-0466
COLORADO
Denver 2: 922 Midland Savings Bldg., 444 17th St., Main 3-1253
ILLINOIS
Chicago 46: 7250 N. Cicero Ave., Lincolnwood, Independence 3-7250
MISSOURI
Joplin: First National Bldg., 402 Main St., Mayfair 4-5060
PENNSYLVANIA
Pittsburgh 22: Room 777, 1 Gateway Center, Atlantic 1-7777
WASHINGTON
Seattle 1: 1127 Washington Bldg., Main 3-8830
WEST VIRGINIA
Huntington 1: 1104 West Virginia Bldg., 4th Ave. & 9th St., Jackson 5-5124

DU PONT DE NEMOURS & CO., INC., E. I., TEXTILE FIBERS DEPT.
191 S. Main St., Akron 8, Ohio

DISTRICT SALES OFFICES
See under ELASTOMER CHEMICALS DEPT.

E

ESCO CORP.
2141 Northwest 25th Ave., Portland 10, Ore.

ESSO STANDARD DIV. OF HUMBLE OIL & REFINING CO.
15 West 51st St., New York 19, N.Y.

DISTRICT SALES OFFICES
PENNSYLVANIA
Avoca: R.D. 2 Suscon Rd., OLympic 4-4669

Bala Cynwyd: City Line Ave. & Esso Rd., TRinity 8-0700
Indiana: Indiana Bulk Plant, Homer City Rd., Route 119, Indiana-Hopkins 5-5608
E. Freedom: East Freedom Bulk Plant, Route 220, Blair County, Hollidaysburg-Owen 5-9815
Johnstown: 335 Swank Bldg., Main & Bedford Streets, Tel: 7-5197
Pittsburgh: Box 4043 Arsenal Station, Museum 2-6613
Reading 2: Reading Bulk Plant, Pottsville Pike, Berks County, Walker 9-0753
TENNESSEE
Chattanooga: Bony Oaks Drive, MA 4-1561
Knoxville: 5009 Middlebrook Pike, N.W., Tel 584-4611
Memphis: 328 Wisconsin Ave., WH 8-5691
Nashville: 1728 28th Ave., N., AL 5-0406
VIRGINIA
Bluefield, FAirfax 6-1213
Norton: Tel: 114
Richlands: WO 1-7475
Roanoke 9: 907 Seventh St., N.E., DIamond 2-8951
WEST VIRGINIA
Beckley: Box 1132, CLifford 3-3811
Charleston 2: McCorkle & Standard Streets, DI 2-8171-2 or 3
Fairmont: Box 32, Tel: 2420
Huntington: JAckson 3-3481
Logan: PL 2-2660
Morgantown: P.O. Box 801, MOrgantown 5515
Rainelle: HE 8-8581
Warwood: Wheeling Bulk Plant, CRestview 7-1300

EUCLID, DIVISION OF GENERAL MOTORS CORP.
Hudson, Ohio

DISTRICT SALES OFFICES
GEORGIA
Atlanta: Suite 3-H, Luckie Bldg., 361 E. Paces Ferry Road, N. E., Cedar 7-6431
MISSOURI
Kansas City: 702 V. F. W. Bldg., 406 West 34th St., Valentine 1-1323

DISTRIBUTORS
ALABAMA
Birmingham: Blackwell-McFarland Euclid Co., Inc., P. O. Box Tarrant 6530, Pinson Highway, Victor 1-6731
Mobile: Blackwell-McFarland Euclid Co., Inc., 3139 St. Stevens Rd., Glendale 7-4356
ILLINOIS
Springfield: Euclid-Illinois, Inc., Terminal Ave. and Highway 66 By-Pass, P. O. Box 759, Kingswood 4-2788
INDIANA
Evansville: Reid-Holcomb Co., Inc 6000 Boonville Highway, Greenleaf 6-1348
Indianapolis: Reid-Holcomb Co., Inc., 1815 Kentucky Ave., Melrose 2-4433
KENTUCKY
Louisville 9: Euclid-Kentucky, Inc., 8500 Grade Lane, P. O. Box 54, Highland Park Station, Emerson 8-1621
MISSOURI
St. Louis 10: Euclid Sales & Service, Inc., 5231 Manchester Ave., Mission 5-3417
NORTH DAKOTA
Fargo: General Diesel & Equipment Co., Inc., W. Main Ave., Highway No. 10, P. O. Box 1537, Adams 5-6674
Williston: General Diesel & Equipment Co., Inc., Highway 2, North, P. O. Box 1016, Greenfield 2-2161
OHIO
Cadiz: The W. W. Williams Co., 700 Lincoln Ave., Windsor 2-2159
Columbus 8: The W. W. Williams Co., 835 W. Goodale Blvd., Capital 8-6651
PENNSYLVANIA
Bridgeville: Anderson Equipment Co., P. O. Box 427, Lehigh 1-6020 or Canal 1-5300
Camp Hill: L. B. Smith, Inc., Regent 7-3431
Kingston: Standard Equipment Co., 340-344 Pierce St., Butler 8-1426
WEST VIRGINIA
Charleston: Mountaineer Euclid, Inc., P. O. Box 8205, Poplar 8-7389

EXIDE INDUSTRIAL MKTG. DIV., ELECTRIC STORAGE BATTERY CO.
Rising Sun & Adams Ave., Philadelphia 20, PA.

DISTRICT SALES OFFICES
ALABAMA
Birmingham 9: 1925 29th Ave., S. Tremont 9-5321
COLORADO
Denver 2: 1515 Cleveland Pl. So., Suite 200, Main 3-7793
GEORGIA
Atlanta 10: 1246 Allene Ave., S. W., Plaza 8-2621
ILLINOIS
Chicago 9: 5335 S. Western Blvd., Walbrook 5-9800
Peoria: 423 1st Nat'l Bank Bkdg. Phone 674-5051
INDIANA
Indianapolis 4: 325 Bankers Trust Bldg., Melrose 5-6727
MISSOURI
Kansas City 23: 129 S. Belmont Blvd., Benton 1-6300
St. Louis 10: 5120 Northrup Ave., Prospect 3-1644
OHIO
Cincinnati 14: 920 E. McMillan St., MAin 1.1-1435
Cleveland 14: 2225 Hamilton Ave., Cherry 1-6231
OREGON
Portland 5: 1224 S.W. Morrison St., Capital 2-3778
PENNSYLVANIA
Philadelphia: 5675 Rising Sun Ave., Fidelity 2-9100
Pittsburgh 16: 2242 Celitorius Ave., Cedar 1-3000
TENNESSEE
Memphis 3: 420 Dermon Bldg., Jackson 6-5842
UTAH
Salt Lake City 7: P.O. Box 7133 Murray Branch, Elgin 9-5766
WASHINGTON
Seattle 1: 500 Wall St., Main 3-1377
WEST VIRGINIA
Charleston 1: 1216 Quarrier St., Dickens 6-8201

F

FAIRBANKS, MORSE & CO.
600 S. Michigan Ave., Chicago 5, Ill.

FAIRVIEW BIT CO., INC.
Fairview, W. Va.

DISTRIBUTORS
ALABAMA
Birmingham: National Mine Service Co., Vestavia Hills, VA 2-0320
NEW MEXICO
Carlsbad: Bit Grinding Service, P. O. Box 803, TU 5-6113
PENNSYLVANIA
Indiana: National Mine Service Co., 1260 Maple St., HO 3-0231
Washington: Fairmont Supply Co., BA 2-5204
WEST VIRGINIA
Beckley: National Mine Service Co., P. O. Box 32, CL 3-7324
Bluefield: U. S. 52 North, Davenport 5-6186
Fairmont: 10th and Belt Line, 2110

FALK CORP., THE
Milwaukee 1, Wisconsin

DISTRICT SALES OFFICES
ALABAMA
Birmingham 3: Brown-Marx Bldg., Room 649, Fairfax 4-1433
ILLINOIS
Chicago 3: 105 W. Adams St., State 2-6686
Peoria: 800 S. W. Adams St., Phone 676-0433
INDIANA
Indianapolis 29: 6349 Guilford Ave., Clifford 5-5434
MARYLAND
Baltimore 12: 4231 Greenmount Avenue, Tuxedo 9-4969
MISSOURI
St. Louis 5: 8029 Forsyth Blvd., Parkview 5-8300
Kansas City 8: (B. L. McCreary & Son) 1819 Central St., Harrison 1-1668
OHIO
Akron 9: (B. W. Rogers Co.) P.O. Box 1030, Portage 2-0251
Cincinnati 2: 609 American Bldg., Main 1-2364
Cleveland 24: P.O. Box 4506, Hillcrest 2-5656
Columbus 12: P.O. Box 5044, Hudson 8-0531
PENNSYLVANIA
Pittsburgh 34: 300 Mt. Lebanon Blvd., Suite 200B, Locust 3-1754
Wynnewood: P.O. Box 313, Midway 9-3335
TENNESSEE
Knoxville 17: (Bowditch & Co.), 1311-C Broadway, N.E. Phone 524-2513
VIRGINIA
Richamond 19: (Williamson & Wilmer), 617 Mutual Bldg., Milton 3-9003
WEST VIRGINIA
Charleston 2: P.O. Box 10066, Riverside 4-1821

FARRELL-CHEEK STEEL CO.
Sandusky, Ohio, Main 5-2340

SALES AGENTS
ALABAMA
Birmingham: Ebbert & Kirkman Co., Inc., 2313 6th Ave., South Alpine 1-9174
CALIFORNIA
San Francisco J. C. Fennelly Co., 1485 Bayshore Blvd., Juniper 4-8121
ILLINOIS
Chicago 40: Mr. Laurence J. White, Uptown Bank Bldg., Long Beach 1-6655
OHIO
Springfield: Mr. Mel Conwell, 109 Bellevue A e., Fairfax 3-6120
Cleveland: Ohio International Co., 75 Public Square, Tower 1-4474
PENNSYLVANIA
Philadelphia 32: Mr. Henry A. Smith, 2727 N. 15th St., Baldwin 8-1420
Pittsburgh 22: Mr. Geo. C. Hitchinson Jr., 800 Keenan Bldg., Atlantic 1-5860
TENNESSEE
Memphis 11: Mr. Hunley A. Slaughter, Box 6403, East Etation, 185 Alexander St., Glendale 2-4278

FEDERAL-MOGUL SERVICE DIV., FEDERAL-MOGUL-BOWER BEARINGS, INC.
11031 Shoemaker Ave., Detroit 13, Michigan

DISTRICT SALES OFFICES
GEORGIA
Atlanta 8: 24 Linden Ave., N.W., Trinity 2-3532
ILLINOIS
Chicago 16: 1923 So. Calumet Ave., Victory 2-2488
INDIANA
Indianapolis 4: 601 N. Capital Ave., Melrose 7-5541
MISSOURI
Kansas City 16: 1313 Atlantic Ave., Victor 2-1047
PENNSYLVANIA
Philadelphia 30: 1839 Wylie St., Poplar 9-2812
Pittsburgh 6: 5472 Penn Ave., Montrose 1-6664
TENNESSEE
Memphis 5A: 905 Estival Place, Jackson 5-0877
VIRGINIA
Richmond 21: 3407 W. Leigh St., Elgin 5-1751

FIRESTONE TIRE & RUBBER CO.
1085 Sweitzer Ave., Akron, Ohio, JE 5-4925

DISTRICT SALES OFFICES
ILLINOIS
Peoria: 400 S. W. Adams St., Phone 637-7721
INDIANA
Indianapolis 25: 200 South Missouri St., ME 7-5461
MISSOURI
Hazelwood: 5928 N. Lindbergh Blvd., PE 1-6880
OHIO
Cincinnati 2: 615 Elsinore Place, PA 1-6816
Columbus 14: 3500 Indianola Ave., AM 7-6333
PENNSYLVANIA
Harrisburg: 3309 North Sixth St., CE 8-7244
Pittsburgh 6: Baum and Negley, MO 1-2100
VIRGINIA
Richmond 24: 1306 Jefferson Davis Highway, BE 3-6941

J. H. FLETCHER & CO.
P. O. Box 2143 Huntington 8, W. Va.

FLOOD CITY BRASS & ELECTRIC CO.
Messenger & Edler Sts. Johntown, Pa. Phone 7-8919

SALES AGENTS
ALABAMA
Birmingham 1: Salmon & Co., Inc., P.O. Box 2388
WEST VIRGINIA
Montgomery: Marathon Coal Bit Co., Inc P.O. Box 391, HI 2-2478

FORD DIV., FORD MOTOR CO.
Rotunda Drive & Southfield, Dearborn, Mich.

FULLER TRANSMISSION DIV., EATON MANUFACTURING CO.
Prouty St., Kalamazoo, Michigan, Fireside 3-2531

DISTRICT SALES OFFICES
CALIFORNIA
Oakland 6: Fuller Transmission Div., 10th St., Templebar 4-9023
OKLAHOMA
Tulsa 3: Fuller Transmission Div., Eaton Mfg. Co., 204 South Cheyenne St., Luther 4-4185

G

GALIS ELECTRIC & MACHINE CO.
Box 2027, Morgantown, W. Va.

GENERAL ELECTRIC CO.
1 River Rd., Schenectady, N. Y.

DISTRICT SALES OFFICES
ALABAMA
Birmingham 3: 1804 Seventh Ave., N.
ARIZONA
Phoenix: 220 Luhrs Tower
CALIFORNIA
Los Angeles 54: 212 N. Vignes St.
COLORADO
Denver 6: 201 University Blvd.
GEORGIA
Atlanta 3: 1860 Peachtree Rd., N. W.
IDAHO
Boise: 1524 Idaho St.
ILLINOIS
Chicago 80: 840 S. Canal St.
INDIANA
Evansville 5: 312 N. W. Seventh St.
Indianapolis 8: 3750 N. Meridian St.
KENTUCKY
Lexington: 628 E. Main St.
Louisville 2: 1216 Starks Bldg.
MICHIGAN
Detroit 2: 700 Antoinette St.
Saginaw: Second Nat'l Bank Bldg.
MISSOURI
Joplin: 220½ W. Fourth St.
Kansas City 5: 106 W. 14th St.
St. Louis 1: 818 Olive St.
MONTANA
Billings: 303 N. Broadway
Butte: 103 N. Wyoming St.
NEBRASKA
Omaha 2: 409 S. 17th St.
NEW MEXICO
Albuquerque: 120 Madeira Drive, N. E.
NORTH CAROLINA
Charlotte 1: 112 S. Tryon St.
OHIO
Cincinnati 6: 2621 Victory Pkwy.
Cleveland 4: 4966 Woodland Ave.
Columbus 15: 395 East Broad St.
Youngstown 7: 272 E. Indianola Ave.
OKLAHOMA
Oklahoma City 2: 119 N. Robinson St.
Tulsa 3: 320 S. Boston Ave.
OREGON
Portland 10: 2929 N. W. 29th Ave.
PENNSYLVANIA
Allentown: 732 North 16th St.
Erie 2: 1001 State St.
Philadelphia 2: 3 Penn Center Plaza
Pittsburgh 22: The Oliver Bldg., Mellon Sq.
TENNESSEE
Chattanooga 2: 832 Georgia Ave.
Memphis 4: 19 South Cleveland St.
Nashville 3: 1717 W. End Bldg.
San Antonio 5: 434 S. Main Ave.
UTAH
Salt Lake City 10: 200 S. Main St.

WASHINGTON
Seattle 4: 710 Second Ave.
Spokane 4: S. 162 Post St.
WEST VIRGINIA
Bluefield: 704 Bland St.
Fairmont: 310 Jacobs Bldg.
Wheeling: 40 14th St.

GOODMAN MANUFACTURING CO.

Halsted St. & 48th Place, Chicago 9, Illinois

DISTRICT SALES OFFICES
ALABAMA
Birmingham 4: 812 Fifth Avenue, Fairfax 3-3222
ILLINOIS
West Frankfort, 304 W. Main St.
KENTUCKY
Harlan, P.O. Box 799, Phone 416
PENNSYLVANIA
Pittsburgh 33: 1714 Liverpool St., Cedar 1-1356
Wilkes-Barre: 35 New Bennett St., Valley 3-3013
WEST VIRGINIA
Huntington 16: 831 Second Ave., Jackson 5-9189

B. F. GOODRICH INDUSTRIAL PRODUCTS

500 So. Main St., Akron 18, Ohio, Blackstone 3-1171

DISTRICT SALES OFFICES
CALIFORNIA
Los Angeles 22: 3525 S. Garfield Ave.
Brisbane: 325 Valley Dr.,
COLORADO
Denver 4: 2500 W. Eighth Ave.
GEORGIA
Atlanta 7: 1721 DeKalb Ave., N.E.
ILLINOIS
Chicago 44: 4646 West Lake St.
MICHIGAN
Allen Park, 16500 Oakwood Blvd.
MISSOURI
St. Louis: 1975 Walton Rd.
OHIO
Akron 18: 500 S. Main St.
Columbus 14: 3770 Indianola Ave.
PENNSYLVANIA
Philadelphia 34: 955 E. Erie Ave.

GRUENDLER CRUSHER & PULVERIZER CO.

2915-2917 North Market St. Louis 6, Mo., Jefferson 1-1220-21-2223

DISTRIBUTORS AND SALES AGENTS
CALIFORNIA
Lakewood 8: J. H. Engelbrecht, 4623 Hackett Ave., Harrison 1-5501
San Fraicisco 22: S. A. Madrid, 2910 Lawton St. Overland 1-8346
COLORADO
Denver 4: Hack Engineering Co., 124 Wazee Market, Taylor 5-5248
GEORGIA
Atlanta: Atlantic Engineering Co., 1468 Mecasslin St., N. W., Trinity 4-9741
ILLINOIS
Chicago: V. E. Winfield & Associates, 407 S. Dearborn, WE-9-0648
LOUISIANA
Baton Rouge 6: Leo Freeman, 2530 Terrace Ave., DI 2-2670
MICHIGAN
Detroit 11: Fors Sales Co., 2832 E. Grand Blvd., Trinity 2-2508
NEW YORK
Orchard Park: D. Michael Cunningham, P. O. Box 286, Idlewood 5885 (Buffalo Exahange)
Rye: Gordon Mosher, Box 57, Woodbine 7-1120
OHIO
Cleveland: Process Industries Equipment Co., 3494 Lee Rd, Washington 1-5580
PENNSYLVANIA
Washington: In-Plant General Co., 21 E. Wheeling St., Baldwin 2-8090
TENNESSEE
Memphis 2: J. E. Dilworth Co., 730 S. 3rd St., Jackson 7-0261

GULF OIL CORP.

Gulf Building, Box 2140, Houston 1, Texas

GUNDLACH MACHINE CO., T. J., DIV. OF J. M. INDUSTRIES

1 Freedom Drive, Belleville, Ill., Adams 3-7208

SALES AGENTS
ILLINOIS
Chicago: Schonthal & Associates, Suite 309, 224 S. Michigan Ave., Wabash 2-8350

PENNSYLVANIA
Greensburg: Andrew M. Gardner, 626 Park Lane, Phone Temple 4-4346
Philadelphia: A. R. Amos Co., 713 Commercial Trust Building, Logan 3-8141
WEST VIRGINIA
Huntington 1: Marshall Equipment Co., Box 1367, Phone Jackson 3-8691
Wheeling: Richard M. Wilson P. O. Box 1198, Phone Chapel 2-1052

H

H & L TOOTH CO.

1540 South Greenwood Avenue Montebello, California

DISTRIBUTORS
ALABAMA
Birmingham: Tractor & Equipment Co. Inc., 4401 First Avenue North
Montgomery: Ray-Brooks Machinery Co Inc. 2275 West Fairview Avenue
COLORADO
Denver: Air Rentals, Inc. 3965 Fox Street
ILLINOIS
Salem: John Fabick Tractor Co.
Marion: John Fabick Tractor Co
INDIANA
Evansville: Reid Holcomb Co., Inc., Boonville Road, East
Indianapolis: Reid-Holcomb Co., Inc., 1815 Kentucky Ave.
South Bend: Reid-Holcomb Co., Inc. West Ireland Road
KENTUCKY
Louisville: Williams Tractor Co. 3800 Crittenden Dr.
Paducah: Williams Tractor Co. 8th & Burnett Sts.
MISSOURI
Kansas City: Buchanan Equipment Co. 2645 Southwest Blvd.
St. Louis: J. Fabick Tractor Co. 3100 Gravois Ave.
Sikeston: J. Fabick Tractor Co.
OHIO
Cincinnati: ABS Contractors Supply Co. 1256 W. Sharon Road
Cleveland: The W. T. Walsh Equipment Co. 12750 Berea Road
Columbus: Capitol Road Machinery Co., 945 W. Third Ave.
PENNSYLVANIA
Harrisburg: Furnival Machinery Co., 5105 Paxton St.
Pittsburgh: Parkway Machinery Co. 635 Ridge Avenue
TENNESSEE
Chattanooga: Power Equipment Co. 1080 Duncan Avenue
Memphis: Tri-State Equipment Co 520 Mulberry Ave.
Nashville: Power Equipment Co. 800 6th Ave.N.
UTAH
Salt Lake City: Heiner Equipment Co., 501 West 7th South
VIRGINIA
Roanoke: J. W. Burress 1701 Shenandoah Avenue N. W.
WEST VIRGINIA
Charlestown: West Virginia Tractor & Equipment Co.
Clarksburg: West Virginia Tractor & Equipment Co. 100 Wood Street

HARNISCHFERGER CORP., CONSTRUCTION & MINING DIV.

4400 National Ave., Milwaukee 14, Wis.

SALES OFFICES
ALABAMA
Birmingham 4: 1629 Vanderbilt Rd., AL 2-8147
ARIZONA
Phoenix: 3300 N. Central Ave., CR 7-2639
COLORADO
Denver: 1108 15th St., AL 5-4876
GEORGIA
Atlanta 5: 361 E. Paces Ferry Rd., CE 3-6018
ILLINOIS
Chicago 6: 110 N. Wacker Drive, AN 3-6510
KENTUCKY
Louisville 21: 429 W. Walnut St., JU 4-3881
MICHIGAN
Detroit 35: 17618 W. McNichlos Rd., KE 7-1120

MISSOURI
Kansas City 6: 1012 Baltimore Bldg., VE 2-3608
St. Louis: 101 S. Meramac Ave. (Clayton), VO 3-3610
OHIO
Cincinnati 37: Roselawn Center Bldg., RE 1-1862
Cleveland 14: 815 Superior Ave., N. E., CH 1-1793
Dayton 19: 53 Park Ave., AX 3-2272
OREGON
Portland 5: 1224 S. W. Morrison St., CA 7-5969
PENNSYLVANIA
Philadelphia 3: 944 Suburban Station Bldg., LO 3-0572
Pittsburgh 16: 1428 Banksville Rd., FI 1-5274
TEXAS
Dallas 7: 1225 N. Industrial Blvd., RI 7-7796
VIRGINIA
Roanoke: 228 Shenandoah Bldg., DI 2-8061
WASHINGTON
Seattle 4: 2909 First Ave., S., MA 2-4924
WISCONSIN
Milwaukee 46: 4601 W. Beloit Rd., OR 1-4400

HAUSER-STANDER TANK CO.

Cincinnati 32, Ohio

HEINTZ MFG. CO.

13110 Enterprise Ave., Cleveland 35, Ohio

HENDRICK MANUFACTURING CO.

Carbondale, Pa.

DISTRICT SALES OFFICES
PENNSYLVANIA
Hazelton: Box 315
Pittsburgh: P.O. Box 10540 (35)

SALES AGENTS
MISSOURI
St. Louis: Crandall Ricker Sales Corp., 1169 Paul Brown Bldg.
ILLINOIS
Chicago 5: Mills Engineering Sales, Inc., 407 S. Dearborn St.
PENNSYLVANIA
Philadelphia: The Benson, Suite 112-C, Washington Lane & Township Line, Jenkintown, Pa.
Pittsburgh 35: Buckley Associates, P.O. Box 10540
OHIO
Cleveland 21: Arthur C. Baker, 4062 Mayfield Rd.
WEST VIRGINIA
Huntingdon: J. Y. Smythe, 832 11th Ave.

HERCULES POWDER CO.

Hercules Tower, 910 Market St., Wilmington 99, Delaware, Olympia 6-9811

DISTRICT SALES OFFICES
ALABAMA
Birmingham 3: First National Building, 17 N. 20th St., Alpine 2-0293
CALIFORNIA
Los Angeles 5: 3460 Wilshire Blvd., Dunkirk 7-8151
San Francisco 4: 120 Montgomery St., Yukon 6-2535
ILLINOIS
Chicago 4: McCormick Bldg., 332 S. Michigan Ave., Harrison 7-5230
MISSOURI
Joplin: First National Bank Bldg., 404 Main St., Mayfair 4-4183
PENNSYLVANIA
Pittsburgh 22: 2 Gateway Circle 603 Stanwix St., Grant 1-6171
UTAH
Salt Lake City 1: Kearns Bldg., 136 S. Main St., Empire 4-5513

HEWITT-ROBINS, INC.

666 Glenbrook Rd., Stamford, Conn.

HEYL & PATTERSON, INC.

55 Fort Pitt Blvd., Pittsburgh 22, Pa.

HOSSFELD MANUFACTURING CO., ROCK DRILL DIVISION

Winona, Minnesota

SALES AGENT
CALIFORNIA
Sun Valley: Leo L. Hitchcock, 12015 Wicks St.

HOYT WIRE CLOTH CO.

P. O. Box 1577, Lancaster, Pa., Express 4-6871

SALES AGENTS & DISTRIBUTORS
ALABAMA
Birmingham: Herbert Hager, P. O. Box 1005, Alpine 1-7251
MARYLAND
Baltimore: William J. Heintz, 1435 Key Highway, Saratoga 7-2252

HUBER-WARCO CO.

Marion, Ohio

DISTRIBUTORS
ILLINOIS
Chicago 52: Gill Boers Equipment Company, 7625 South Kedzie Avenue
INDIANA
Lawrence 26: Deeds Equipment Co., Inc., 8015 E. 45th St., P.O. Box 8414
Rochester: Deeds Equipment Company Inc., 913-915 Main Street
KENTUCKY
Louisville 13: Rudd Construction Equipment Co., Inc., 4344 Poplar Level Road
NORTH CAROLINA
Charlotte: Spartan Equipment Co., 1922 Bancroft St., P.O. Box 5222
OHIO
Cadiz: The W. W. Williams Company, 700 Lincoln Ave.
Cincinnati 41: The W. W. Williams Co., 11563 Mosteller Rd., Sharonville
Cleveland: The W. W. Williams Co., 18301 Brookpark Road
Columbus 8: The W. W. Williams Co., 835 West Goodale Blvd.
Maumee: The W. W. Williams Co., 1230 Conant Street, P.O. Box 309
PENNSYLVANIA
Corry: Corry Bridge & Supply Co.
Deven: Road Machinery, Inc., U.S. Highway 30
Wilkes Barre: Ensminger & Co., 57 Wood St., P.O. Box 848
Mechanicsburg: American Equipment Corporations, York & Allen Streets, P.O. Box 149
Pittsburgh 6: Brinker Supply Co., 6545 Hamilton Ave.
TENNESSEE
Chattanooga: Story Brothers, Inc., 919 Dodds Avenue
Knoxville 18: Story Brothers, Inc., 4130 Clinton Highway, P.O. Box 4166
Memphis: Southland Tractors, Inc., 105 South Parkway West P.O. Box 3187
Nashville 4: McCarthy, Jones & Woodward, 723 Argyle Ave., P.O. Box 9068
VIRGINIA
Richmond 30: Municipal Sales Co. Inc., 1823 North Hamilton Ave., P.O. Box 6217
WEST VIRGINIA
Huntington: Porter Supply Co., 1703 Seventh Ave., P.O. Box 736

HULBURT OIL & GREASE CO.

Trenton & Castor Avenues, Philadelphia 34, Penna.

DISTRICT SALES OFFICES
ILLINOIS
West Frankfort: P.O. Box 59, Tel. 867M
KENTUCKY
Harlan: P.O. Box 611, Tel. 955
White Plains: P.O. Box 125, Tel. Oriole 6-3404, Nortonville, Ky.
Pikeville: P.O. Box 499, Tel. General 7-7107
OHIO
Adena: P.O. Box 637, Kimball 6-2361
PENNSYLVANIA
Forty Fort, 43 Welles St., Butler 7-4762
Greensburg, Pa. 522 Hampton St., Temple 7-5555
Johnstown, Pa., 221 Bertmin St., Tel. 32-1274
WEST VIRGINIA
Fairmont: P.O. Box 1181, Fairmont 1249
Fayetteville: P.O. Box 21, Tel. 527
South Charleston: 1242 Ridge Dr., Poplar 8-6490
Logan: P.O. Box 1402, Plaza 2-6558
Fairmont: 127 Marion St., Fairmont 4666-R

WAREHOUSES
ALABAMA
Birmingham: American Transfer Warehouse Co., Inc., P.O. Box 2543, Fairfax 3-1501

ILLINOIS
West Frankfort: Frank Russel & Son, 401 S. Ida St. Tel. 77
INDIANA
Evansville 7: Evansville Warehouse Co., 28 S. E. 8th St., Harrison 4-1234
KENTUCKY
Harlan: McComb Supply Co., Tel. 361
Pikeville: Pikeville Warehouse, Scott Ave., General 7-7107
Madisonville: Line Service Co., TA 1-7168
PENNSYLVANIA
Johnstown: Replogle Storage Co., 438 Horner St., Tel. 9-8713
Pittsburgh 19: Shovel Transfer & Storage Co., 210 W. Carson St., Express 1-4212
Wilkes Barre: Matheson Warehouse Co., Elizabeth St., Forty Fort, Pa., BU 7-5495
TENNESSEE
Jellico: McComb Supply Co., Garfield 4-8441
VIRGINIA
Andover: Central Supply Co. of Virginia Inc., Tel. 115
W. VIRGINIA
Fairmont: P.O. Box 1221, Tel. Fairmont 2681
Fayetteville: P.O. Box 21, Tel. 527
Henlawson: Logan City, Hulburt Oil & Grease Co., Plaza 2-1153
Wheeling: Penna & W. Va. Supply Corp., P.O. Box 871, Linden 7-4710

I

INTERNATIONAL HARVESTER CO., CONSTRUCTION EQUIPMENT DIV.

180 North Michigan Ave., Chicago 1, Illinois

DISTRICT SALES OFFICES
ILLINOIS
Peoria: 407 Rock Island Ave., P.O. Box 1019
Springfield: 126 West Jefferson St., P.O. Box 99
KENTUCKY
Louisville: 1326 West Walnut St.
MARYLAND
Baltimore: 6501 Quad Ave., P.O. Box 1085
OHIO
Cincinnati 1: 2901 Gilbert Ave., P.O. Box 85
Columbus 4: 3700 Sullivant Ave., P.O. Box 2797
Toledo 1: 43 Fearing St.
PENNSYLVANIA
Harrisburg: 1017 Maclay St.
Leetsdale: 1000 Ferry St.
TENNESSEE
Memphis 2: 237 West Olive Ave P.O. Box 2864
VIRGINIA
Richmond 23: 1702 East Clay St.

DISTRIBUTORS
ILLINOIS
East Peoria: McElroy-Roland Machinery Co., 2580 Morton Road
Quincy: Missouri-Illinois Tractor & Equipment Co., Inc., U.S. Highway No. 24, Box 328
Rockford: Howell Tractor & Equipment Co., Route 51 & Samuelson Road, P.O. Box 39
Springfield: McElroy-Roland Machinery Co., 816 N. 31st St.
KENTUCKY
Louisville: Brandeis Machinery & Supply Co., 201 Warnock St., Box 1705
Middlesboro: Brandies Machinery & Supply Co., North 19th St., Box 515
Paducah: Brandeis Machinery & Supply Co., U.S. Hwy, 45, Box 906
MARYLAND
Baltimore: Phillips Machinery & Tractor Co., 325 West 23rd St.,
OHIO
Cincinnati: Rish Equipment Co., Box "O" Hampden Station 1212 Dalton Ave., Box 120
Cleveland: Rish Equipment Co., 9255 Brookpark Road, Box 7303
Columbus: Rish Equipment Co., 3131 Beulah Road, Box 6398
Dayton: Rish Equipment Co., 2375 Dryden Road, Box 543
Toledo: Rish Equipment Co., 101 North Westwood, Box 206 Station C
Youngstown: Rish Equipment Co., 250 Indinola Ave., Box 2669
PENNSYLVANIA
Franklin: State Equipment Co., 655 Grant St.
Harrisburg: State Equipment Co., 3725 North Front St., Box 412
Kingston: State Equipment Co., 642 West Market St.
Philipsburg: State Equipment Co., Box 667
Pittsburgh: State Equipment Co., 8436 Perry Highway
TENNESSEE
Chattanooga 5: Power Equipment Co., 1080 Duncan Ave., Box 3158
Kingsport: Power Equipment Co., 121 Clay St., Box 597
Knoxville 15: Power Equipment Co., Alcoa Hwy. Box 2311
Nashville 3: Power Equipment Co., of Nashville, 808 Sixth Ave., North
VIRGINIA
Arlington: Phillips Machinery & Tractor Co., 2910 Jefferson Davis Highway
Norfolk 8: Hampton Roads Tractor & Equipment Co., Inc., West 39th St. & Killiam Ave., Box 237
Richmond 10: Rish Equipment Co. 1601 Chamberlayne Ave., Box 1260
Roanoke 7: Rish Equipment Co., 405 Center Ave., N.W. Box 1369
WEST VIRGINIA
Bluefield: Rish Equipment Co., Box 269
Bluefield: Rish Equipment Co., N. on U.S. 52, Box 1261
Charleston 22: Rish Equipment Co., Kanawha Boulevard at Patrick St., Box 353
Clarksburg: Rish Equipment Co., East on U.S. Route 50, Box 2227
Parkersburg: Rish Equipment Co., 140 Nineteenth St., Box 1728

J

JAMISON FEEDER, INC.

Hunkers, Pa.

THE JEFFREY MFG. CO.

974 North Fourth St., Columbus 16, Ohio

ALABAMA
Birmingham 5: 3012 Fourth Ave., South, Fairfax 2-8516
COLORADO
Denver 22: 2150 South Bellaire, SKyline 7-1283
INDIANA
Evansville 7: 1066 Diamond Ave., Harrison 4-8206
KENTUCKY
Harlan: Martins Fork Road, P.O. Dr. 472, Phone: 400
PENNSYLVANIA
Pittsburgh 22: 1424 Oliver Bldg., Court 1-2926
UTAH
Salt Lake City: 9100 South 150 East, Sandy, AMherst 5-1451
WEST VIRGINIA
Bluefield: 1703 Jefferson St., P.O. Box 731, Davenport 5-7165

SERVICING AGENTS
INDIANA
Evansville: Evansville Electric & Mining Co.
KENTUCKY
Harlan: National Electric Service Corp.
PENNSYLVANIA
Portage: Leman Machine Co.
WEST VIRGINIA
Bluefield: National Electric Coil Co.

JOY MFG. CO.

Henry W. Oliver Bldg., Pittsburgh 22, Pa.

DISTRICT SALES OFFICES
COLORADO
Denver 2: 1626 Wazee St., Keystone 4-6334
ILLINOIS
Chicago 6: 560 W. Washington Blvd., Dearborn 2-4670
MISSOURI
St. Louis 10: 1203 Macklind Ave., Mission 5-6670
MONTANA
Butte: 24 W. Granite St., Phone 6721
OHIO
Cleveland 35: 16141 Puritan Ave., Clearwater 1-9444
ORGEON
Portlant 9: 1631 N.W. Thurman St., Capital 7-5561
PENNSYLVANIA
Luzerene: 453 Main St., Butler 8-4523
Philadelphia 2: 1420 Walnut St., Pennypacker 5-1414
Pittsburgh 16: 3021 Banksville Rd., Locust 3-4000
TENNESSEE
Knoxville 2: 108 W. Main St., Phone 522-4121
UTAH
Salt Lake City 4: 998 S. Sixth West St., Davis 2-0481
WASHINGTON
Seattle 9, 422 First Ave., West, Atwater 3-5979
WEST VIRGINIA
Fairmont: P.O. Box 1045, Phone 1740
Huntington: 742 8th Ave., Jackson 3-3439

DISTRIBUTORS
ALABAMA
Birmingham: Crandall Engineering Co., 601 N. 10th St., Alpine 1-9262
COLORADO
Denver 2: Schlos & Shubart, 1626 Wazee St., Acoma 2-2741

K

KENNAMETAL INC., MINING TOOL DIV.

Bedford, Pa., Phone 623-5134

DISTRICT SALES OFFICES
ILLINOIS
Benton: 505 E. Lawrence St., Phone GE 8-8811
KENTUCKY
Barbourville: 419 S. Main St., Box 337, Lincoln 6-3727
Belfry: Box 28, Phone Williamson, W. Va. AD 7-4468
OHIO
Crooksvillle: 303 Walnut St., Phone 4104
PENNSYLVANIA
Cadogan: Phone: Roger 2-9964
Glenshaw: 107 Orchard Ave., Hunter 6-5722
Mars: Box 236, National 5-9011
Rimersburg: Drawer "J", Phone 113
Waynesburg: Morning Side, RD No. 3 Phone 1734 (Orval Robson) Phone: 1076
Wyoming: 41 Shulde Lane, Phone: Wyoming 49
TENNESSEE
Chattanoogа 11: 1314 S. Seminole Dr., Oxford 83021
UTAH
Springville: 164 W. 2 St., Hunter 9-5541
VIRGINIA
Staunton: 803 Cherryhill Drive, Phone TU 6-9238
WEST VIRGINIA
Bluefield: Box No. 834, Davenport 7-8376
Morgantown: P.O. Box 1133, Phone Linden 2-9503
Oak Hill: 368 Kelly Ave., Hobart 9-9544

DISTRIBUTORS
ALABAMA
Birmingham: Salmon & Co., Inc.
KENTUCKY
Jenkins: National Mine Service Co.
Madisonville: National Mine Service Co.
MICHIGAN
Ishpeming: Burridge - Nyland Equipment Co.
NEW MEXICO
Carlsbad: Bit Grinding Service In
PENNSYLVANIA
Forty-Fort: National Mine Service Co.
Indiana: National Mine Service Co.
Latrobe: McGinnis Bros. Bit Service Inc.
Washington: Fairmont Supply Co.
VIRGINIA
Andover: Central Supply of Virginia Inc.
McClure: Erwin Supply Co.
WEST VIRGINIA
Beckley: National Mine Service Co.
Bluefield: Fairmont Supply Co.
Cowen: Pennsylvania & West Virginia Supply Corp.
Fairmont: Fairmont Supply Co.
Logan: National Mine Service Co.
Morgantown: National Mine Service Co., Pennsylvania/West Virginia Supply Corp.
Ravensood: Fairmont Supply Co.
Shinnston: Erwin Supply Co.
Triadelphia: Pennsylvania & West Virginia Supply Copr.

KW-DART TRUCK CO.

Kansas City, Mo., 1301 North Machester Tfwy., HU 3-7679

SALES OFFICES
OHIO
Cleveland: T. E. Sullenger, 12525 Edgewater Dr., Apt. 222
North Ridgeville: H. A. Noreen, 34554 Lorain Road

DISTRIBUTORS
ALABAMA
Birmingham: Leary & Owens Machinery, 3600 5th Ave.
Montgomery: Leary & Owens Equipment Co., 3165 Mobile Road
INDIANA
Indianapolis: Flesch-Miller Tractor Co., 4611 Franklin Road
ILLINOIS
Chicago, Gil Boers Equipment Company, 7625 S. Kedzie
KENTUCKY
Lexington: Wilson Machinery & Supply Co., 550 West 4th Street
OHIO
Cleveland: T. E. Sullenger, 12525 Edgewater Dr., Apt. 222
Columbus: Cantwell Machinery Co., 830 North Cassady Ave.
PENNSYLVANIA
Pittsburgh: Parkway Machinery, Inc., 635 Ridge Ave.
TENNESSEE
Nashville: McCarthy, Jones & Woodard, 723 Argyle Ave.
UTAH
Salt Lake City: J. T. Jenkins Co., 2281 S.W. Temple
VIRGINIA
Richmond: Highway Machinery & Supply Co., 1724 Altamont Ave.
WEST VIRGINIA
Charleston: West Virginia Tractor & Equipment Co., P.O. Box 473

L

LEE-NORSE CO.

Charleroi, Pa., Hudson 3-6516

DISTRICT SALES OFFICES
COLORADO
Arvada: 6030 W. 55th Place, Harrison 4-2795
Boulder: 2975 18th Street, Hillcrest 3-6169
VIRGINIA
Pocahontas: Pocahontas Warehouse, Wilson 5-6945
WEST VIRGINIA
Bluefield: 112 Virginia Court, Davenport 5-7229

SALES AGENTS
ALABAMA
Birmingham: J. L. Thomas Company, 429 South 24th Street., Fairfax 4-7032

LE ROI DIV., WESTINGHOUSE AIR BRAKE CO.

Milwaukee 1, Wisc.

DISTRIBUTORS
ALABAMA
Birmingham: Equipment Service Co., Inc., 617 N. 9th St.
Mobile: Equipment Service Co., Inc., 405 N. Royal Street
COLORADO
Denver: Denver Air Machinery Co., 1421 Blake St.
INDIANA
Evansville: Austin Powder Co., 616 Northwest Second St., P.O. Box 177
KENTUCKY
Madisonville: Austin Powder Co., 39 Federal St., P.O. Box 146
UTAH
Salt Lake City: Atlas Equipment Co., 2525 South 2nd West, P.O. Box 26
WEST VIRGINIA
Clarksburg: West Virginia Mine Supply Co., P.O. Box 1359
Huntington: Acme Machinery Co., Altizer Ave. & High Sts., (P.O. Box 2409)
Morgantown: Acme Machinery Co., Box 631

LeTOURNEAU-WESTINGHOUSE CO., WESTINGHOUSE AIR BRAKE DIV.

Peoria, Ill.

DISTRICT SALES OFFICES
UTAH
Salt Lake City

DISTRIBUTORS
ALABAMA
Oneonta: Robbins Machine & ufacturing Co., Inc., Highway 75 North, P. O. Box 281, CR 4-3011
COLORADO
Denver: Tudor Equipment Co., 6198 Dahlia St., ATlas 8-1512

ILLINOIS
Elmhurst: Illinois Contractors' Machinery, Inc., Route 83 & Madison St., P. O. Box 462, TErrace 4-7100
Marion: Hutton Machinery Co., P. O. Box 368, WYandotte 3-2604
Peoria: Illinois Contractors' Machinery, Inc., 2306 Glen Ave. West, 685-5255
Rock Island: Illinois Contractors' Machinery Inc., 520—11th St., 788-5532
INDIANA
Fort Wayne: Stockberger Machinery, Inc., 630 High St., ANthony 4346
Indianapolis: Miller Machinery, Inc., 7255 W. Washington St., P. O. Box 21085, CHapel 1-2511
South Bend: Stockberger Machinery, 308 S. Olive, CEntral 3-7059
KENTUCKY
Lexington: Contractors Equipment Company, Inc., 780 E. Third St., P. O. Box 1059, 2-1475
Madisonville: Contractors Equipment Company, Inc., 1300 S. Main, P. O. Box 96, TA 1-4789
MONTANA
Billings: Western Construction Equipment Co., 505 N. 24th St., P. O. Box 2537, ALpine 9-5501
Butte: Roberts Rocky Mountain Equipment Co., 215 S. Colorado, 2-9191
Great Falls: 2322 River Drive, P. O. Box 1504, Glendale 3-1405
OHIO
Cleveland: Cleveland Contractors Equipment Co., 10904 Brookpark Rd., SHadyside 1-5570
Columbus: Columbus Equipment Co., 50 E. Kingston Ave., HIckory 3-6541
Toledo: Columbus Equipment Co., 3038 No. Reynolds Rd., JEfferson 1-1465
OKLAHOMA
Oklahoma City: Wylie-Stewart Machinery Co., Inc., 1400 Exchange Ave., P. O. Box 1985, CEntral 2-8831
Tulsa: Wylie-Stewart Machinery Co., Inc., 2443 Dawson Rd., P. O. Box 3216, Whittier Sta., LUther 7-2518
PENNSYLVANIA
Harrisburg: Furnival Machinery Co., 5101 Paxton St., JOrdon 4-1781
Philadelphia: Furnival Machinery Co., Lancaster Ave. at 54th St., TRinity 7-5200
Pittsburgh: A. T. Green Machinery Co., P. O. Box 9538, STerling 1-9600
Pottsville: Furnival Machinery Co., P. O. Box 553, MArket 2-8020
TENNESSEE
Chattanooga: Nixon Machinery & Supply Co., Inc., 1300 Carter St., P. O. Box 149, AM 7-5573
Knoxville: Nixon Machinery & Supply Co., Inc., 4717 Clinton Highway, P. O. Box 3034, 687-1601
Nashville: Nixon Machinery & Supply Co., Inc., 1211 Demonbreun St., P. O. Box 176, AL 5-5688
UTAH
Salt Lake City: Rocky Mountain Machinery Co., 1485 S. 2nd West, P. O. Box 2037, HUnter 4-4378
VIRGINIA
Lynchburg: Richmond Machinery & Equipment Co., Inc., 3920 Campbell Ave., P. O. Box 1278, VIctor 5-6066
Richmond: Richmond Machinery Equipment Co., Inc., 1701 Roseneath Rd., P. O. Box 6736, ELgin 9-4048
WEST VIRGINIA
Charleston: Machinery, Inc., 2855 Piedmont Rd., P. O. Box 2911, Walnut 5-4741.

LIMA WORKS, CONSTRUCTION EQUIP. DIV., BALDWIN-LIMA-HAMILTON CORP.

Lima, Ohio: S. Main St., CA-40421

DISTRICT SALES OFFICES

GEORGIA
Atlanta 18: 1503 Northside Drive, N.W., Station D, TRinity 2-5833
INDIANA
Michigan City : 2503 Lake Shore Drive, TRiangle 2-2598
OHIO
Lima: S. Main St., CA 4-0421

DISTRIBUTORS

ALABAMA
Birmingham 6: G. C. Phillips Tractor Co., Inc., Woodlawn Station, 4419 First Ave., N., WOrth 1-4605
Mobile: 849 Telegraph Rd., GU 7-7695
ILLINOIS
Chicago 32: Arrow Contractors Equipment Co., 4646 South Kedzie Avenue, FRontier 6-6500
Peoria: Machinery, Inc., 3601 Farmington Rd., 4-1174
Springfield: Springfield, Machinery, Inc., R.R. 1 8-7303
INDIANA
Evansville: Ried-Holcomb Company, Inc., Boonville Road East, GR 6-1348
Indianapolis 21: 1815 Kentucky Avenue, MElrose 2-4433
KENTUCKY
Louisville 9: Euclid-Kentucky, Inc., 8500 Grade Lane
MISSOURI
St. Louis 10: Machinery Inc., 5081 Manchester Avenue, JEfferson 5-2056
OHIO
Cleveland 30: Cleveland Contractors Equipment Co., 10904 Brookpark Road, SHadyside 1-5570
Columbus 7: Columbus Equipment Company, 50 East Kingston Ave., HIckory 3-6541
OKLAHOMA
Oklahoma City: R. A. Young & Son, Inc., 1507 Exchange Avenue, CE 6-5465
PENNSYLVANIA
Harrisburg: Highway Equipment & Supply Company, 5100 Paxton Street, JOrdan 4-3031
Haxleton: Frank Swabb Equipment Co., Inc., Suite 313, Haleton National Bank Bldg., GLadstone 5-3658
Pittsburgh 6: Highway Equipment Company, 6465 Hamilton Avenue, EMerson 1-3600
TENNESSEE
Knoxville: Euclid-Knoxville, Inc., 2600 Middlebrook Pike
Memphis 5: Priester Machinery Company, 249 S. Third Street, JAckson 5-6885
VIRGINIA
Roanoke: J. W. Burress, Inc., 1701 Shenandoah Ave., N.W., DIamond 3-1507
WEST VIRGINIA
Charleston: Machinery, Inc., 2855 Piedmont Road, QAlnut 5-4741
Clarksburg: West Virginia Mine Supply Co., 212 Ohio Avenue, MAin 4-7491
CANADA
Regina, Saskatchewan: Blackwood Hodge Western Ltd., Lorne Street at 7th Avenue
Winnipeg 3, Manitoba: 1350 Wall Street, SPruce 5-7181

LINATEX CORP. OF AMERICA

P.O. Drawer "D" Stafford Springs, Conn.: or Wilkins Linatex, Ltd., 1975 Bois Franc Rd., St. Laurent, Quebec, Canada

DISTRIBUTORS

ILLINOIS
Elmhurst: Mr. Eric Lof, Mid-Western States, P.O. Box 481, Terrace 4-2425
PENNSYLVANIA
Pittsburgh 19: S. E. Gane Co., 508 Grant St.
UTAH
Bountiful: Mr. A. R. Beatty, Western States, 387 West 1050 North, Axtel 5-2700

LINK-BELT CO.

Dept. CAMGL-61, Prudential Plaza, Chicago 1, Ill.

DISTRICT SALES OFFICES

ALABAMA
Birmingham 9: P.O. Box 6066, 1812-28th Ave., South, Tremont 1-1101
COLORADO
Denver: Schloss & Shubart, 1626 Wazee St., Acoma 2-2741
ILLINOIS
Chicago 9: 303 W. Pershing Rd., Atlantic 5-4401*
INDIANA
Indianaipols 6: 220 S. Belmont Ave., Melrose 2-5411*
KENTUCKY
Louisville 8: 235 E. Burnett St., Melrose 7-3668
MICHIGAN
Detroit 4: 5938 Lindsdale Ave., Tyler 4-1100*
MISSOURI
Kansas City 8: 2630-Homes St., Victor 2-9234*
St. Louis 1: 31' N. 11th St., Chestnut 1-1777
OHIO
Cleveland 20: 3592 Lee Rd. Wyoming 1-0380
PENNSYLVANIA
Pittsburgh 13: 5020 Center Ave., Museum 1-060*
WASHINGTON
Seattle 4: 3405 6th Ave. S. Seneca 8200*
WEST VIRGINIA
Huntington 1: 100 95th Ave., P.O. Box 510, Jackson 3-9401
CANADA
Scarboro Toronto 13 Ont: Link-Belt Ltd. 1960 Eglinton Ave., P.O. Box 173 Station H, Plymouth 5-4141* Cable: Linkbelt Toronto

LONG-AIRDOX CO.

Div. of Marmon-Herrington, Inc. Maple Ave., P.O. Box 331, Oak Hill, W. Va.

SALES OFFICES

ILLINOIS
Chicago 1: 307 N. Michigan Ave., RAndolph 6-5353
WEST VIRGINIA
Oak Hill: Maple Ave., HObart 9-3301

DISTRICT SALES OFFICES

ALABAMA
Birmingham: 921 Barnisdale Rd., Sherwood, VErnon 6-6879
COLORADO
Louisville: Tel Boulder, Colo., HIllcrest 2-7298
ILLINOIS
Benton: P.O. Box 479, GEneral 8-3821
INDIANA
Evansville: 307 N. Fifth St., HArrison 2-8944
IOWA
Ottumwa: Tel. MUrray 4-6564
KENTUCKY
Robinson Creek: Tel. Virgie, Ky., 639-4493
OHIO
St. Clairsville: P.O. Box 1, OXford 5-1790
PENNSYLVANIA
Finleyville: R. D. No. 2, DIckens 8-7143
Uniontown: P.O. Box 1293, Tel. GEneva 7-2793
WEST VIRGINIA
Camden-on-Gauley: Tel. Cowan, W. Va., 226-3571
Morgantown: 389 Birch St., LInden 9-4556

DISTRIBUTORS

ARKANSAS
Fort Smith: R. A. Young & Son, Inc., 301 S. Tenth St., SUnset 3-8901
ILLINOIS
Rockford: Eighmy Equipment Co. 120 S. Pierpoint Ave., WOodland 4-6706
INDIANA
Brazil: Shaffer & Co., 1324 E. National St., 12-926
KENTUCKY
Louisville: Virgil Heck Equipment Co., 928 E. Mason St., JUniper 4-6281
OHIO
Cleveland: Rish Equipment Co., 9255 Brookpark Rd., SHadyside 9-4200
TENNESSEE
Knoxville: Power Equipment Co., P.O. Box 2311, Tel. 3-1121
VIRGINIA
Richmond: Bemiss Equipment Co., 2219 Chamberlayne Ave., ELgin 9-5766
WEST VIRGINIA
Charleston: West Virginia Tractor & Equipment Co., 1701 Mercer Ave., DIckens 6-5301

LONGYEAR CO., E. J.

76 South 8th St., Minneapolis 2, Minnesota

DISTRICT SALES OFFICES

MINNESOTA
Minneapolis 2: E. J. Longyear Co., 76 So. 8th St., FE 9-7631

DISTRIBUTORS

COLORADO
Denver 16: Union Supply Co., 5460 Colorado Blvd., P. O. Box 6735 Stockyards Station

IDAHO
Idaho Falls: Southern Idaho Equipment Co., P. O. Box 2498
MARYLAND
Hyattsville: Chesapeake Supply & Equipment Co., 4726 Baltimore Ave.
MISSOURI
Bonne Terre: Bonne Terre Farming & Cattle Co.
NORTH CAROLINA
Charlotte: Mitchell Distributing Co., Inc., 3535 Hutchison Ave.
WASHINGTON
Seattle 4: The Carrington Co., 91 Columbia St.
Spokane 2: Rowand Machinery Co., No. 808 Division St.

LUDLOW-SAYLOR WIRE CLOTH CO.

4537 W. Clayton Ave., St. Louis 10, Mo., Franklin 1-0636

DISTRICT SALES OFFICES

ALABAMA
Birmingham: 512 N. 18th St., Alpine 2-5151
COLORADO
Denver: 1530 Carr St., Belmont 3-5421
ILLINOIS
Chicago 39: 6261 W. Grand Ave., National 2-1147
PENNSYLVANIA
Pittsburgh: Union Trust Bldg., Atlantic 1-2262
TEXAS
Houston: 5638 Harvey Wilson Dr., Walnut 1-0291

M

MACWHYTE WIRE ROPE CO.

2906 14th Ave., Kenosha, Wis.

DISTRICT SALES OFFICES

CALIFORNIA
Los Angeles 33: 185 S. Myers St., AN 8-2884
San Francisco 7: 188 King St., EX 2-3139
GEORGIA
Atlanta 18: 1091 Herndon St., S. W., Tel 79-41557
ILLINOIS
Chicago 6: 228 S. Desplaines St., RA 6-2653
MICHIGAN
Detroit 3: 75 Oakman Blvd., TO 8-8178
OREGON
Portland 9: 1603 N. W. 14th Ave., CA 6-6588
PENNSYLVANIA
Pittsburgh 36: 353 Curry Hollow Rd., TU 4-3707
TENNESSEE
Memphis: 254 N. Front St., JA 6-7897
TEXAS
Ft. Worth 1: T. & P. Terminal Whse., ED 2-8436
WASHINGTON
Seattle 4: 87 Holgate St., MA 2-5774

AMERICAN-MARIETTA CO.

Marietta, Ohio: Frontier 3-3211

MARIETTA CONCRETE DIV.,

American-Marietta Co., Mariett Ohio, Frontier 3-3211

SALES OFFICES

MARYLAND
White Marsh: P.O. Box 173, Murdock 7-9494
OHIO
Marietta, P.O. Box 669, Frontier 3-2121

DISTRIBUTORS

ILLINOIS
Chicago: Mayer & Oswald, 407 So. Dearborn St., Harrison 7-0528
OHIO
Eaton: Lee R. Neff, 625 N. Barron St., Gladstone 6-4850
PENNSYLVANIA
Pittsburgh 22: Mann Engineering Co., 503 Bessemer Bldg., Atlantic 1-2950

MARION POWER SHOVEL CO.

Marion, Ohio

DISTRICT SALES OFFICES

ILLINOIS
Chicago: 332 S. Michigan Ave., Wabash 2-2701 & 2
INDIANA
Indianapolis: 5202 E. Dickson Rd., Liberty 7-4314

MISSOURI
Kansas City: 1016 Baltimore Ave., Rm. 309, Harrison 1-4228
St. Louis: 4378 Lindell Blvd., Jefferson 5-7727
NEW YORK
New York: 4240 Boston Post Road, FAirbanks 4-1017
OHIO
Columbus: 2245 Nottingham Rd, Hudson 6-2054
PENNSYLVANAA
Emmaus: 105 Spruce St., Woodering 5-2900
Pittsburgh: 609 Kenilworth Dr., Lehigh 1-4446

DISTRIBUTORS

ALABAMA
Oneonta: Robbins Machine & Mfg. Co., Inc., Highway 75, North, Crestwood 4-3011
INDIANA
Indianapolis: Flesch-Miller Tractor Co., 4611 Franklin Road, Liberty 6-2491
KANSAS
Pittsburg: Henry W. Hubert Supply Co., 814 North Broadway, Phone Adams 1-2230
MISSOURI
Kansas City: Machinery & Supplies Co., Inc., 2000 Walnut St., Victor 2-5457
St. Louis: Ryan Equipment Co., 3350 Morgansford Rd., Prospect 1-0292
OHIO
Cincinnati: Bode-Finn Co., 2650 Spring Grove Ave., Mulberry 1-2200
Cleveland: J. J. Turner, Inc., 19451 Roseland Ave., Ivanhoe 1-9308
Toledo: Buckeye State Machinery, Inc., 3020 Reynolds Rd., Jefferson 1-1494
Dover: Weaver Truck Trailer & Body Corp., 2405-15 N. Wooster Ave., Phone 4-2391
PENNSYLVANIA
Carnegie: Allied Equipment Corp., 1 Glass St., Browning 9-5000
Philadelphia: Furnival Machinery Co., Lancaster Ave. at 54th St., Trinity 7-5200

MCDOWELL MFG. CO.

301 Stanton Ave., Pittsburgh 9, Pa., Taylor 1-1333

DISTRICT SALES OFFICES

PENNSYLVANIA
Pittsburgh 9: Millvale: 301 Stanton Ave., Taylor 1-1333

DISTRIBUTORS

PENNSYLVANIA
Pittsburgh 12: Frick & Lindsay Co., 117 Sandusky St., Fairfax 1-5700
Pittsburgh 12: Petroleum Pipe & Supply Co., Inc., 1529 Federal St., Cedar 1-2800

McLANAHAN CORP.

Hollidaysburg, Pa., Phone 5-9807

DISTRIBUTORS

ALABAMA
Birmingham: Shook & Fletcher Supply Co., 1814 First Avenue, North, Fairfax 2-6722
ILLINOIS
Chicago: McLanahan Corp. (Chicago Office) 407 S. Dearborn St. WAbash 2-0733
INDIANA
Muncie: Van Doren Machinery Sales, 2503 Linden St., ATlas 4-4811
KENTUCKY
Madisonville: Kert E. Reed Co., Box 415
OHIO
Columbus: Cantwell Machinery Co., 830 N. Cassady Avenue, Clearbrook 8-9561
UTAH
Salt Lake City: The National Equipment Co., 1020 South 6th West, EM 3-8878
VIRGINIA
Roanoke: McIlhany Equipment Co., Inc., Corner 14th St. & Center Ave., N.W., Diamond 3-3669
WEST VIRGINIA
Bluefield: R. W. Massie, 1325 Lebanon St., Davenport 7-8461
Charleston: Persingers, I nc.,520 Elizabeth Street, Dickens 6-5341
Williamson: Persinger Supply Co. Belmont 5-1400

MERRICK SCALE MFG. CO.

184 Autumn St., Passaic, N.J.

DISTRICT SALES OFFICES

ILLINOIS
Chicago: J. A. Marx, 400 West Madison St., Room 1904, FI 6-6786
KENTUCKY
Louisville: Charles Gipperich, P.O. Box 386, Glendale 4-4036
MISSOURI
Kansas City 12: W. C. Carolan Co., 612 West 47th St., Jefferson 1-5505
St. Louis: W. C. Carolan Co., 4030 Chouteau Ave., Jefferson 5-5525
OHIO
Cleveland: Hird & Son, P.O. Box 2855, Edison 1-7272
PENNSYLVANIA
Pittsburgh: R. P. Hoppe Company, 300 Cedar Blvd., Fieldbrook 1-8400
TENNESSEE
Chattanooga 2: Edgar A. Rogers, Chattanooga Bank Bldg., Amherst 7-4640
VIRGINIA
Richmond 19: C. Arthur Weaver Co., Inc., 2612 West Cary St., Richmond, Elgin 9-5771
CANADA
Ontario, Toronto 9: Hagan Corp. (Canada) Ltd., P.O. Box 69, Station D, Rogers 2-8285

METALLURGICAL PRODUCTS DEPT., GENERAL ELECTRIC CO.

P.O. Box 237, Roosevelt Park Annex, Detroit 32, Michigan

MINING TOOL DISTRIBUTORS

ALABAMA
Birmingham: Shook & Fletcher Supply Co., 1814 First Ave., North, FAirfax 2-6722
COLORADO
Denver: Mine & Smelter Supply Co., Inc., P.O. Box 9041, 3800 Race St.
ILLINOIS
Mt. Vernon: Pickard Industires, Inc., Central Mine Supply Div., 423 South 8th St., CH 2-6262
INDIANA
Terre Haute: The Mine Supply Co., Inc., 417 North 13th St., CRawford 8150
KENTUCKY
Harlan: Kentucky Mine Supply Co., Inc., Tel. 1500
Hazard: Speck Corent Supply Co., GEneral 64822
Madisonville: Pickard Industries, Inc., Central Mine Supply Div., TA 1-2810
Pikeville: Big Sandy Electric & Supply Co., 331 Hellier St., Tel. 234
OHIO
Cambridge: Cambridge Machine & Supply Co., Inc., Phone 2-2421
OREGON
Portland: J. E. Haseltine & Co., 115 S. W. Second Ave., CApital 8-7511
PENNSYLVANIA
Bell Vernon: Mining Tool Service, Lee Supply Co., Box 88, R. D. No. 2, Tel. 2156
Charleroi: Mining Tool Service, Lee Supply Co., P.O. Box 35, HUdson 3-8933
Washington: Fairmont Supply Co., 437 Jefferson Ave., BAldwin 2-5200
UTAH
Salt Lake City: Mine & Smelter Supply Co., 121 West 2nd South EMpire 3-2791
VIRGINIA
Andover: Central Supply Co. of Va., Inc., APplaachia 115
McClure: Erwin Supply Co., Phone 2311
WEST VIRGINIA
Bluefield: Bluefield Supply Co., 100 Mercer St., DAvenport 5-6131
Bluefield: Fairmont Supply Co., U.S. 52 North
Bluefield: Rish Equipment Co., U.S. Route 52
Charleston: Rish Equipment Co., Kanawa Blvd. at Patrick St. Bridge, DIckens 6-0831
Clarksburg: Rish Equipment Co., East on U.S. 50, VIctor 2-3511
Fairmont: Fairmont Supply Co., Tenth St. & Belt Line, Tel. 2110
Montgomery: Marathon Coal Bit Co., Drawer 391, HIllside 2-2478
Shinnston: Erwin Supply Co., P.O. Box 5, SHinnston 477

MINE & SMELTER SUPPLY CO.

3800 Race Street, Denver 5, Colorado, Cherry 4-4353

DISTRICT SALES OFFICES

NEW MEXICO
Albuquerque: Mine and Smelter Supply Co., 701 Haines Ave., N. W. Chapel 7-4141
UTAH
Salt Lake City: Mine and Smelter Supply Co., 121 West Second South, Em 3-2791

DISTRIBUTORS AND OR SALES AGENTS

WEST VIRGINIA
Fairmont: Fairmont Machinery Co., Fairmont 1672

MINERS' HARDWARE SUPPLY CO.

Martin Bldg., Pittsburgh 12, Pa., Fairfax 1-3013 & Allegheny 1-7257

SALES AGENT

WEST VIRGINIA
Bluefield: A. W. Hageman, Box 241

MINE SAFETY APPLIANCES CO.

201 N Braddock Ave., Pittsburgh 8, Pa., Churchill 1-5900

DISTRICT SALES OFFICES

ALABAMA
Brimingham: 2500 12th Ave., N., Alpine 4-3403
ARIZONA
Tucson: 1906 E. 18th St., Main 3-1814
COLORADO
Denver: 2916 Forest St., Florida 51588
ILLINOIS
Benton: 110 Hudelson St., General 9-2861
KENTUCKY
Harlan: Third St., Rio Vista, Phone 130
Pikeville: P.O. Box 546, General 7-6675
MINNESOTA
Duluth: 1703 East Third St., RAndolph 4-1997
MISSOURI
St. Louis 3: 1915 Washington Ave., Main 1-2252
MONTANA
Butte: 2419 Princeton; Ph. 6875
PENNSYLVANIA
Johnstown: 220 Leila St., Phone 35-1007
Pittsburgh 8: 201 North Braddock Ave., Churchill 1-5900
Uniontown: 624 Fayette Nat. Bank Bldg., Geneve 8-7351
Scranton 10: 530 Clay Ave., Diamond 6-3062
UTAH
Salt Lake City 1: 257 Rio Grande St., Empire 4-6044
VIRGINIA
Abingdon: P.O. Box 608, Market 2843
WEST VIRGINIA
Bluefield: 1513 Bluefield Ave., Davenport 7-5171
Bridgeport: 523 Pennsylvania Ave Victor 2-3230
Fairmont: 1313 Peacock Lane Phone Fairmont 366-0871
Williamson: 38 Sunset Blvd., Belmont 5-5330
CANADA
Calgary, Alberta: 3632 Burnsland Rd., Chestnut 3-4092
Nova Scotia, Sydney: 150 Charlotte St., Phone 4517-8
Ontario, Tornoto 4: 500 MacPherson Ave., Walnut 5-1101
Vancouver, B.C.: 293-11th Ave. East, Trinity 4-5711

MINING PROGRESS, INC.

P.O. Box 3, Highland Mills, N. Y. Tel. 928-6916

NACHOD & UNITED STATES SIGNAL CO., INC.

4780 Crittenden Dr., Louisville 9, Ky., Emerson 3-3571

SALES OFFICES

UTAH
Salt Lake City 15: 18 East Stratford Ave., IN 7-5997

N

NATIONAL CASTINGS CO.

10600 Quincy Ave., Cleveland 6, Ohio

NATIONAL MINE SERVICE CO.

Koppers Bldg., Pittsburgh 19, Pa.

DISTRICT SALES OFFICES

ALABAMA
Birmingham
ILLINOIS
Nashville
KENTUCKY
Ashland
Jenkins
Madisonville
PENNSYLVANIA
Mt. Carmel
Indiana
UTAH
Price
WEST VIRGINIA
Beckley
Logan
Morgantown
CANADA
Elliot Lake, Ontario: National Mine Service (Canada) Ltd.

NOLAN CO., THE

Bowerston, Ohio, Phone 6-2771 & 6-2781

DISTRIBUTORS

ALABAMA
Birmingham: J. L. Thomas, 429 So. 24th St., Phone 54-7032
COLORADO
Denver 2: E. C. Horne Machinery Co., 1726 Champa St., Tabor 5-7015
ILLINOIS
Chicago: J. N. North Associates, P.O. Box 105, Harbert, Mich., New Buffalo, Mich., Lakeside 4106
PENNSYLVANIA
Pittsburgh: George C. Hutchinson, Jr., 800 Keenan Bldg., Atlantic 1-5860
UTAH
Castle Gate: Frank C. Memmott, P.O. Box 154, Phone Kennilworth, Utah, Granite 2-5094
WEST VIRGINIA
Huntington: Huntington Supply & Equipment Co., Huntington National Bank Bldg., Jackson 25562
CANADA
(Ontario) Toronto: Levitt-Safety Limited, 747 Vaughan Rd.

NORTONS-TIVIDALE, LTD.

307 North Michigan Ave., Chicago 1, Ill.

O

OHIO BRASS CO.

360 North Main St., Mansfield, Ohio

DISTRICT SALES OFFICES

INDIANA
Evansville 13: 1414 S.E. First St., Harrison 2-2869
KENTUCKY
Neon: P.O. Box 187, Neon 2441
PENNSYLVANIA
Johnstown: 1513 Luzerne St., P.O. Box 301, Phone: 35-1274
Pittsburgh 22: 1017 Oliver Bldg., Mellon Sq., Atlantic 1-1727
WEST VIRGINIA
Bluefield: 424 Parkway, P.O. Box 1616, Davenport 5768-4
Fairmont: 1219 Bell Run Rd., Phone: 7379

SALES AGENT

ALABAMA
Birmingham 2: Shook & Fletcher Supply Co., Agent, 1814 First Ave., North, P.O. Box 2631, Fairfax 2-6722

THE OKONITE CO.

220 Passaic St., Passaic, N. J.

P

PASADENA HYDRAULICS INC.

1433 Lidcombe, El Monte, Calif.

PENNSYLVANIA CRUSHER DIV., BATH IRON WORKS CORP.

West Chester, Pa.

DISTRICT SALES OFFICES & AGENTS

ALABAMA
Birmingham 5: J. L. Thomas, 429 S. 24th Street, Fairfax 4-7032

ILLINOIS
Chicago 3: V. H. Jones Company, 100 W. Monroe Street, Financial 6-1667
MISSOURI
St. Louis 26: G. O. Thompson, 9703 Holliday Gardens, Apt. D, Harrison 9-5628
PENNSYLVANIA
Pittsburgh 22: E. P. Dandridge, 412 Oliver Bldg., Atlantic 1-0485
TENNESSEE
Knoxville 19: Crowell Engineering Co., 3055 Sutherland Ave. P.O. Box 10287, Tel. 588-5122
UTAH
Salt Lake City: The Mine and Smelter Supply Company, 121 W. Second Street, Empire 3-2791

PETERSON FILTERS & ENGINEERING CO.

1949 South 2nd West, P.O. Box 606, Salt Lake City 10, Utah

DISTRIBUTORS
PENNSYLVANIA
Pittsburgh 28: James A. Redding Co., Mfg. Rep., 634 Washington Rd.
WEST VIRGINIA
St. Albans: H. L. Miller, Mfg. Rep., 1154 Summit Drive

PHELPS DODGE COPPER PRODUCTS CO.

300 Park Ave., New York 22, N. Y.

SALES OFFICES
ALABAMA
Birmingham 5: 3524 Fourth Ave., S., Fairfax 3-1636
COLORADO
Denver 2: 621 17th St., Cherry 4-9291
GEORGIA
Atlanta 3: 903 Candler Bldg. Murray 8-2322
ILLINOIS
Chicago 3: 100 West Monroe St., Franklin 2-6336
Chicago: 1940 N. Janice Ave., Melrose Park, Estebrook 8-1685
INDIANA
Fort Wayne 1: 4400 New Haven Ave., Eastbrook 0511
Indianapolis 4: 5 East Market St., Melrose 9-2596
IOWA
Des Moines 10: 202 Plaza Office Bldg., Merle Hay Pl., Browning 6-4565
MICHIGAN
Detroit 26: 28 West Adams Ave., Woodward 1-4090
Lansing: 736 Samantha, Turner 2-2750
MISSOURI
St. Louis 3: 1221 Locust St., Chestnut 1-4110
OHIO
Cincinnati 2: 49 East 4th Ave., Cherry 1-7843
Cleveland 13: 50 Public Square, Prospect 1-2666
Dayton 2: 30-38 N. Main St., Baldwin 2-5503
OREGON
Portland 9: 1436 N.W. 16th Ave., Capitol 6-6117
PENNSYLVANIA
Philadelphia 32: 3105 W. Allegheny Ave., Baldwin 5-6600
Pittsburgh 22: 535 Smithfield St., Express 1-1550
TENNESSEE
Memphis 1: Union Planters Natl. Bank Bldg., Jackson 5-7726
VIRGINIA
Richmond 30: 1000 Thompson St., Elgin 5-6521
WASHINGTON
Seattle: 808 106th Ave., N. E., Bellevue, Wash., Glencourt 4-5026
WISCONSIN
Milwaukee 16: 711 West Capitol Dr., Franklin 4-3490

PLM PRODUCTS, INC.

3871 West 150th St., Cleveland 11, Ohio, Clearwater 2-6222

PORTER CO., INC., H. K., LESCHEN WIRE ROPE DIV.

2727 Hamilton Ave., St. Louis 12, Mo.

SALES OFFICES
CALIFORNIA
Los Angeles 54: Leschen Wire Rope Div., H. K. Porter Company, Inc., P.O. Box 54128, Terminal Annex RAymond 3-0393
San Francisco: Leschen Wire Rope Div., H. K. Porter Company, Inc. 1485 Bayshore Blvd., JUniper 7-6903
GEORGIA
Atlanta 19: Leschen Wire Rope Div., H. K. Porter Company, Inc., 1238 Fernwood Circle, N. E. CEdar 3-8422
ILLINOIS
Elk Grove Village: Leschen Wire Rope Div., H. K. Porter Company, Inc., 2567 Greenleaf Ave., NAtional 5-9310
NEW JERSEY
Newark 5: Leschen Wire Rope Div., H. K. Porter Company, Inc., 219 Emmet Street, BIgelow 2-8400
OKLAHOMA
Oklahoma City 4: Leschen Wire Rope Division, H. K. Porter Company, Inc., 216 S. Klein Street, CEntral 5-7657
PENNSYLVANIA
New Kensington: Leschen Wire Rope Division, H. K. Porter Company, Inc., 450 Second St., EDison 5-9877

DISTRIBUTORS
ILLINOIS
Peoria: Varrco Distributing Co., 618 S. W. Adams
KANSAS
Pittsburg: General Machinery & Supply Co., 202 N. Broadway
KENTUCKY
Lothair (Perry Co.): Mine Service
Louisville: Brandeis Machinery & Supply Co., P.O. Box 906
Madisonville: Hart Equipment Co., 122 E. Center St.
Madisonville: Mine Equipment & Supply Co., 149 Dempsey Street
OHIO
Canton: Ralph Williams, Inc. 429 Waynesburg Raod, S. E.
Somerset: C. H. & D. Supply Co., P.O. Box 125
Zanesville: Goss Supply Co., 620 Marietta
OKLAHOMA
Picher: Consolidated Supply Co., P.O. Box 367
PENNSYLVANIA
Clearfield: Clearfield Equipment Co., Old Town Road
Harrisburg: Cobb Wire Rope & Supply Co., 4220 Paxton St.
Pittsburgh: Cobb Wire Rope & Supply Co., 501 McNeilly Road
WEST VIRGINIA
Bluefield: Bluefield Hardware Co., 400 Bluefield Ave.
Charleston: Capital City Supply Co., Box 833
Kermit: Controller Block & Supply Co.

PORTER CO., INC., H. K., THERMOID DIV.

200 Whitehead Rd., Trenton 6, New Jersey

DISTRICT SALES OFFICES
CALIFORNIA
Los Angeles 22: 6900 E. Elm St.
So. San Francisco: 129 Sylvester St.
GEORGIA
Atlanta 8: 730 Peachtree St., N.E.
ILLINOIS
Elk Grove: 2567 Greenleaf Ave.
OHIO
Cincinnati 15: 430 Mill St.
PENNSYLVANIA
Philadelphia 24: Tacony & Comly Sts.
WASHINGTON
Seattle 4: 902 First Ave., South

POST-GLOVER ELECTRIC CO.

Box 709, Covington, Ky.

SALES OFFICES OR DISTRIBUTORS
PENNSYLVANIA
Greensburg: Andrew M. Gardner, 626 Park Lane, Tel. 3350
WEST VIRGINIA
Beckley: C. H. Carson, Box 999, Clifford 2-5185
Bluefield: C. H. Litz, Box 48, Davenport 7-9220
Wheeling: R. M. Wilson Co., P.O. Box 1198, Cedar 2-8430

PROX CO., INC., FRANK

1201 S. First St., Terre Haute, Ind.

DISTRIBUTORS
COLORADO
Denver: Ralph B. Moore & Co.
PENNSYLVANIA
Uniontown: Tri State Mine Supply Co.
WEST VIRGINIA
Huntington: Marshall Equipment Co.

R

RIDGE EQUIPMENT CO.

Fallentimber, Pa.

JOHN A. ROEBLING'S SONS DIV. THE COLORADO FUEL & IRON CORP.

Box 321, Trenton 2, N.J.

DISTRICT SALES OFFICES
CALIFORNIA
Los Angeles 22: 5340 E. Harbor St., Raymond 3-6421
COLORADO
Denver 16: 4801 Jackson St., Fremont 7-2769
GEORGIA
Atlanta 10: 934 Avon Ave., S.W., Plaza 3-2151
ILLINOIS
Chicago 50: 5525 W. Roosevelt Rd., Bishop 2-1100
OHIO
Cincinnati 15: 10350 Evendale Drive, Princeton 1-6990
Cleveland 7: 13225 Lakewood Heights Blvd., Clearwater 2-6060
OKLAHOMA
Tulsa: 321 North Cheyenne St., Luther 2-5194
PENNSYLVANIA
Philadelphia: Market 7-2751
WASHINGTON
Seattle 4: 900 First Ave., South, Capitol 7-7221

ROME CABLE DIV. OF ALCOA

421 Ridge St., Rome, N. Y., FF 7-3000

DISTRICT SALES OFFICES
ILLINOIS
Chicago 11: Rome Cable Div. of Alcoa, 520 N. Michigan Ave., Whitehall 3-4766
MISSOURI
St. Louis 8: Rome Cable Div. of Alcoa, 3615 Olive St., Franklin 1-6700
PENNSYLVANIA
Pittsburgh 20: Rome Cable Div. of Alcoa, 875 Greentree Rd., Atlantic 1-4545

DISTRIBUTORS
KENTUCKY
Lothair: Mine Service Co., Inc., General 6-3191
Middlesboro: Rogan & Rogan, Middlesboro 89
Pikeville: Big Sandy Electric & Supply Co., P. O. Box 162, General 7-6296
PENNSYLVANIA
Pittsburgh 3: Mosebach Electric & Supply Co., 1115 Arlington Ave., Hemlock 1-8332
Washington: Fairmont Supply Co., 437 Jefferson Ave., Baldwin 2-5200
WEST VIRGINIA
Beckley: Anchor Sales Co., P. O. Box 210, Clifford 3-9400
Bluefield: Fairmont Supply Co., U. S. 52 North, Davenport 5-6186
Charleston: Virginian Electric Inc., P. O. Box 2833, Dickens 6-0631
Cowen: Pennsylvania & West Virginia Supply Corp., Cowen 2601
Elm Grove: Pennsylvania & West Virginia Supply Corp., Linden 7-4710
Fairmont: Fairmont Supply Co., 10th & Belt Line, Fairmont 2110
Morgantown: Pennsylvania & West Virginia Supply Corp., Morgantown 4435

THE RUSSELL MANUFACTURING CO.

Middletown, Conn.

DISTRIBUTORS
WEST VIRGINIA
Mt. Hope: West Virginia Belt Sales, Inc.

RUTTMANN CONSTRUCTION CO.

425 West Walker St., Upper Sandusky, Ohio

S

SALEM TOOL CO., THE

767 S. Ellsworth Ave., Salem, Ohio, Edgewood 7-3416

DISTRIBUTORS
ALABAMA
Birmingham 4: Cowin Equipment Co., 930 2nd Ave. N.
ARKANSAS
Fort Smith: R. A. Young & Son, Inc.
Little Rock: R. A. Young & Son, Inc., 301 S. 10th St.
COLORADO
Denver 16: Union Supply Co., 5460 Colorado Blvd.
ILLINOIS
Mt. Vernon: Ed. Meyer Tractor Co.
INDIANA
Evansville: Austin Powder Co., Box 177
IOWA
Spreitzer, Inc., U.S. 30 West, Cedar Rapids
KANSAS
Pittsburg: W. A. Thomas Supply Co., 112-114 W. Pacific
KENTUCKY
Lexington 6: Wilson Machinery & Supply, 561 W. 4th St.
Louisville 18: Wilson Mach. & Supply Co., Box 165, Sub Sta
Owensboro: 2601 W. 4th St.
MONTANA
Helena: Hall-Perry Machine Co., 123 E. Lawrence St.
OHIO
Cincinnati 14: Rish Equipment Co., P.O. Box 120 (Annex Sta.)
Cleveland 29: Rish Equipment Co., P.O. Box 7303
Columbus 11: Rish Equipment Co., P.O. Box 6398, Oakland Park Branch
Dayton 9: Rish Equipment Co., P.O. Box 543
Steubenville: Voto Mfg. & Sales Co., 525 N. Webster
Toledo 7: Rish Equipment Co., P.O. Box 206 (Sta. C)
Youngstown 7: Rish Equipment Co., 250 E. Indianola Ave.
OKLAHOMA
Tulsa: R. A. Young & Sons, Inc., 9401 E. Admiral Pl.
PENNSYLVANIA
Bethel Park: Whitmyre Equipt. Co., H., 336 Sunset Drive
SOUTH DAKOTA
Sioux Falls: J. D. Evans Equip. Co., 500 S. Cliff Ave.
TENNESSEE
Chattanooga: Nixon Machinery & Supply Co., 1300 Carter St.
Knoxville: Nixon Machinery & Supply Co., 3042 N. Central Ave.
Nashville: Nixon Machinery & Supply Co., 1211 Demonbreun St.
UTAH
Salt Lake City 15: Western Machinery Co., 2300 S. Main St.
VIRGINIA
Richmond: Rish Equipment Co., P.O. Box 1260
Roanoke: Rish Equipment Co., P.O. Box 1369
WASHINGTON
Seattle 4: Clyde Equipment Co., 3410 1st Ave. S.
Seattle: The Carrington Co., 91 Columbus St., (Alaskan Rep.)
WEST VIRGINIA
Bluefield: Rish Equipment Co., P.O. Box 269
Charleston 22: Rish Equipment Co., P.O. Box 353
Clarksburg: Rish Equipment Co., P.O. Box 2227
Parkerburg: Rish Equipment Co., P.O. Box 1728
CANADA
Montreal, Que: Mussens Canada, Ltd., 65 Colborn St.

SCHRAMM, INC.

West Chester, Pa., Owen 6-2500

DISTRICT SALES OFFICES
ILLINOIS
Chicago 39: 5550 W. North Ave., Tu 9-4412
PENNSYLVANIA
Gibsonia: 3915 Dickey Rd., HI 3-2550

DISTRIBUTORS
ALABAMA
Birmingham 1: 913 N. Seventh Ave. (Box 550), Stoelker Equipt. Co. Inc., FA 2-5451
INDIANA
Petersburg: Fred Mallotte Machinery Co., Highway 61, EL 4-8818
KENTUCKY
Danville: Central Supply & Equipment Co., Inc., 908 Perryville St., Code 236-6760
MISSOURI
Bloomsdale: D. W. Machinery Co., P. O. Box 4, HU 3-2560

OHIO
Dayton 2: Dayton Equipment Co., Inc., 525 S. Perry St., BA 4-9634
PENNSYLVANIA
Clearfield: Clearfield Equipment Co., Old Town Rd., PO 5-5559
Pittsburgh 37: State Equipment Co., 8436 Perry Highway, WE 11-13 Tompkins St., OL 4-6711
Pittston: Medico Industries, Inc., 1-4040, FO 4-0200
TENNESSEE
White Pine: Tennessee Well Supply Co., So. State St., (Box 308), Code 674-2997
WEST VIRGINIA
Charleston: Machinery, Inc. P. O. Box 2911, WA 5-4741
Clarksburg: West Virginia Mine Supply Co., 212 Ohio Ave. (Glen Elk 2), P. O. Box 1359, MA 4-7491

SCHROEDER BROS.

Nichol Ave., McKees Rock, Pa.

DISTRIBUTORS

ALABAMA
Birmingham 4: Equipment Service Co., Inc., 617 North 9th St., FA 4-4438
COLORADO
Denver 7: Ralph B. Moore Co., 3847 Forest St., Cherry 4-2969
UTAH
Price: Cate Carbon Equipment Co., Me 7-2266

SECURITY ENGINEERING DIV., DRESSER INDUSTRIES, INC.

3400 West Illinois, Dallas, Tex., Federal 1-3211

SALES OFFICE

PENNSYLVANIA
Lemoyne (Harrisburg): 310 S 10th, RE 7-8113

DISTRIBUTORS

PENNSYLVANIA
Frostburg: Stockdale Mine Supply
Harrisburg: Stephenson Equipment, P.O. Box 69, Hill Station
Hazleton: Vic Bruno Co., Inc.
Washington: Fairmont Supply, 437 Jefferson Ave.
WEST VIRGINIA
Montgomery: Marathon Coal Bit Co., P.O. Box 391, HI 2-2478

SALES OFFICE

WISCONSIN
Milwaukee: 3287 N. Oakland Ave., WO 4-0740

DISTRIBUTORS

ILLINOIS
Mt. Vernon: Central Mine Supply Co., Div., 423 South Eighth, CH 2-6262
KENTUCKY
Madisonville: National Mine Service Co., P.O. Box 409
UTAH
Salt Lake City: Christensen Diamond Products Co., 1937 S. 2nd W. Str., HU 4-5321

SHELL OIL CO.

50 W. 50th St., New York 20, N. Y.

DISTRICT SALES OFFICES

GEORGIA
Atlanta 1: P.O. Box 1703
ILLINOIS
Chicago 5: 624 S. Michigan Blvd.
LOUISIANA
New Orleans 7: P. O. Box 673
MARYLAND
Baltimore 4: P. O. Box 6870
MICHIGAN
Detroit 26: 154 Bagley Ave.
MISSOURI
St. Louis 66: P. O. Drawer 22
OHIO
Cleveland 1: P. O. Box 5818
WASHINGTON
Seattle 11: 1219 Westlake Ave., N.

SIMPLEX WIRE & CABLE CO.

79 Sidney St., Cambridge 39, Mass.

SKF INDUSTRIES INC.

Front St. & Erie Ave., Philadelphia, Pa.

DISTRICT SALES OFFICES

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Birmingham 12: 607 N. 31st St., ALpine 1-8781
COLORADO
Denver 2: 1420 N. 18th St., MAin 3-3924
GEORGIA
Atlanta 9: 1052 W. Peachtree St., N. W. TRinity 5-8846
ILLINOIS
Melrose Park: 1800 N. 25th Ave., MAnsfield 6-7456 (Chicago) FIllmore 5-5150 (Suburban)
MISSOURI
St. Louis 10: 2149 Hampton Ave., MIssion 7-3444
OHIO
Cincinnati 37: 6115 Wiehe Rd., Redwood 1-7117
Cleveland 18: 13426 Cedar Rd., Yellowstone 2-1340
NORTH CAROLINA
Charlotte 3: 2935 Griffith St., Jackson 3-6262
PENNSYLVANIA
Pittsburgh 37: 9800 McKnight Rd. Wellington 1-2955

STEARNS MAGNETIC PRODUCTS DIV., INDIAN GENERAL CORP.

635 S. 28th St., Milwaukee 46, Wis.

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ALABAMA
Birmingham: William H. Neville, Rm 247, American Life Bldg., ALpine 1-7979
ARIZONA
Phoenix: National Equipment Co. 35 East Pierson St., AMherst 5-0019
CALIFORNIA
San Francisco: Transmission Engineering Co., 427 Bryant St., SUtter 1-4738
COLORADO
Denver: Schloss & Shubart, 1626 Wazee St., AComa 2-2741
ILLINOIS
Chicago: Norm J. Chivas, 7012 West North Ave., TUxedo 9-4323
MISSOURI
St. Louis 19: Schleiffarth Industrial Equipment Co., 5701 Manchester Ave., STerling 1-8192
Kansas City: Boyd Goodhart & Associates, 2201 Grand Ave., 601 Merchandise Mart, BAltimore 1-9839
NORTH CAROLINA
Charlotte: M. R. Snyder Co., 304 East Tremont Ave., ED 4-7190
OHIO
Cincinnati: J. F. Riess & Associates, 7023 Miami Ave., LOcust 1-4170
Cleveland: Hird & Son, 19630 Detroit Road, P.O. Box 2855, EDison 1-7272
OREGON
Portland: John H. Marvin Co., 2166 Northwest Wilson St., CApitol 7-2551
PENNSYLVANIA
Philadelphia: Joos Equipment Co., Summit Grove & Lancaster Ave., Bryn Mawr, LAwrence 5-6261
Pittsburgh: F. C. Anderson Co., P.O. Box 104, Glenshaw, Sterling 2-2515
TENNESSEE
Memphis: Engineered Products Co., 4385 Janice Drive, MUtual 3-3019
UTAH
Salt Lake City 4: National Equipment Co., 1020 S. Sixth West, EMpire 3-8878
VIRGINIA
Richmond: Herbert J. Baer, Box 131, MIlton 8-3090
WASHINGTON
Seattle: John H. Marvin Co., 427 Fourth Ave., W., ATwater 4-0331
ONTARIO
Toronto: Geo. Rumble Co., Ltd., Haas & Tabor Roads, Rexdale CH 1-3885
QUEBEC
Montreal: Geo. Rumble Co., Ltd., 3333 Cavendish Blvd., HUnter 4-3533
BRITISH COLUMBIA
Vancouver: B. C. Equipment Co., Ltd., 551 Howe St., MArino 2511

SUN OIL CO.

1608 Walnut St., Philadelphia 3, Pennsylvania, KI 6-1600

DISTRICT SALES OFFICES

ILLINOIS
Oak Park (Chicago): 1515 N. Harlem Ave., Euclid 3-4100
INDIANA
Indianapolis: 715 E. 52nd St., Walnut 4-4513
KENTUCKY
Louisville 16: Bramer's Lane, Spring 6-4681
MISSOURI
St. Louis 3, 3419 Papin St., Prospect 1-9364
OHIO
Cincinnati 4: 2414 River Rd., Wabash 1-5500
Columbus 4: 3499 W. Broad St., Broadway 9-9421
Youngstown 12: 6331 Southern Blvd., Skyline 8-4581
PENNSYLVANIA
Allentown, Old Emmaus Pike, R. D. 2, Hemlock 4-9531
Exeter: 7 Kern St., Olympic 4-6795
Greensburg: Roosevelt Way & Route 119, Temple 7-4700
Johnstown: Tunnel Ave., Riverside Johnstown 33-2111
Pittsburgh 38: Freeport Road & Boyd Ave., Sterling 1-1252
WEST VIRGINIA
Huntington: 13th & Beach Sts., Kenova, Jackson 3-9045
Wheeling: Stop No. 22, River Road, Crestview 7-1122

T

TEMPLETON, KENLY & CO.

Broadview, Ill.

DISTRICT SALES OFFICES

PENNSYLVANIA
Pittsburgh: N. L. Montgomery, 245 Mabrick Ave. Fieldbrook 1-6357

DISTRIBUTORS

ALABAMA
Birmingham: Lewis Hardware Co., 420 N. 9 St.;
Moore-Handley Inc., 27 S. 20th St.
Wimberly & Thomas Hardware Co., 1809 Ave. A.
COLORADO
Denver: Mine & Smelter Supply Co., Inc., 3800 Race St.
ILLINOIS
Du Quoin: Du Quoin Iron & Supply Co., Inc., Adams & Hickory
Mt. Vernon: Central Mine Supply Co., 218 So. 3rd St.
Murphysboro: Egyptian Sales Agency, 401 S. 17th St.
Peoria: Couch & Heyle, 1016 S. Adams
INDIANA
Evansville: Austin Powder Co., Inc., 616 N.W. 2d St.
Drillmaster Supply Co., 1117 E. Division St.
Orr Iron Co., 1100 Pennsylvania St.
Terre Haute: Hardware Supply Co., Inc., 930-940 Chestnut St.
Industrial Supply Co., 322-328 N. 9th St.
Mechanical Suppliers, Inc., 100 N. 9th St.
KANSAS
Pittsburg: General Machinery & Supply Co., 202 N. Broadway
KENTUCKY
Harlan: Kentucky Mine Supply Co., River St.
Hazard: Sterling Hardware Co., Inc., 124 Main St.
Madisonville: Austin Powder Co., 39 Federal St.
Paducah: Henry A. Peter Supply Co., 101-129 S. 1st St.
OHIO
Cambridge: Cambridge Machinery & Supply Co., 128 Steubenville Ave., Drawer 426
Cincinnati: Wm. T. Johnston Co., 1870 Summit Rd.;
E. A. Kinsey Co., 331 W. 4th St.
Steubenville: Industrial Supplies Co., 324 N. 7th St.
Warren: Bert Park Co., 1199 Vine Ave., N.E.
Warren Hdwe. Co., P.O. Box 1191
Zanesville: Buckeye Supply Co., 18 Harrison St.
OKLAHOMA
Oklahoma City: Marshall Supply & Equipment Co., 705 N. Virginia
Mideke Supply Co., 100 E. Main
Tulsa 1: Leland Equipment Co., 408 Main St.
Marshall Supply & Equipment Co., 920 E. Archer
PENNSYLVANIA
Forty Fort: National Mine Service
Greensburg: Westmoreland Hardware Co., 326 Mt .Pleasant St.
Indiana: Whitman Div. of National Mine Service Co., 1260 Maple St.
Johnstown: Quaker Sales Corp., P.O. Box 870; Thackray Co., 1036 Broad St.
Pittsburgh: Cooke-Wilson Electric Supply, 1787 N. Hiland Rd.
C. A. Turner Inc., P.O. Box 928
Frick & Lindsay Co., Sandusky & Robinson Sts.
Harris Pump & Supply Co., Brady & Sidney Sts.
Pittsburgh Gage & Supply Co., P.O. Box 1168
Somer Fitler & Todd Co., 327 Fort Pitt Blvd.
Scranton: Bittenbender Co., 126-132, Franklin Ave.
Washington: Fairmont Supply Co., 437 Jefferson Ave.
W. Brownsville: Ward Supply Co., Inc.
Wilkes-Barre: Eastern Penn. Supply Co., Inc., 56 S. Pennsylvania
TENNESSEE
Johnson City: Summers Hardware & Supply Co.
Knoxville: C. M. McClung & Co., 501 W. Jackson Ave.
Tennessee Mill & Mine Supply Co., 406 State St.
Tidewater Supply Co., P.O. Box 377
UTAH
Salt Lake City: Industrial Supply Co., Inc., Box 600
Mine & Smelter Supply Co., 121 W. 2nd South
VIRGINIA
Andover: Central Supply Co. of Virginia
Applachia: Central Supply Co. of Virginia
Grundy: Buchanan-Williamson Supply Co., Box 933
McClure: Erwin Supply Co., Inc.
WASHINGTON
Seattle: Campbell Industrial Supply Co., 3433 Airport Way at Spokane St.
The Carrington Co., 91 Columbia St.
Tacoma: Hunt & Mottet Co., 2112 Pacific Ave.
WEST VIRGINIA
Beckley: Anchor Sales Co., 373 Prince St., Box 210,
National Mine Service Co.
Bluefield: Bluefield Hardware Co., 400 Bluefield Ave.
Bluefield Supply Co., P.O. Box 269
Superior Sterling Co., 200 Bluefield Ave.
Charleston: Capital City Supply Co., 522-524 Broad St., Box 883
McJunkin Corp., P.O. Box 513
Persingers Inc., 520 Elizabeth St., P.O. Box 1866, Rish Equipment Co., Box 353
Clarksburg: Rish Equipment Co., Box 2227
Cowen: Penna. & W. Va. Supply Corp.
Elkins: Valley Supply Co., 11th St. & Railroad Ave.
Elm Grove: Pa. & West Va. Supply Corp.
Fairmont: Fairmont Supply Co., 10th & Belt Line
Huntington: Banks-Miller Supply Co., 330 3d Ave.
Ensign Electric & Mfg. Co., 914 Adams Ave.
Branchfield Pipe & Supply Co., Box 486
Logan: Guyan Machinery Co., Inc.
Logan Hardware & Supply Co., 300 Highland Ave.
Morgantown: Pa. & West Va. Supply Corp., Wall St.
Shinnston: Erwin Supply Co., P.O. Box 5
Wheeling: Pa. & West Va. Supply Corp., P.O. Box 871
Williamson: Persinger Supply Co., 33 W. 3d Ave., Drawer 491
Williamson Supply Co., 206 W. 2nd Ave.
WYOMING
Cheyenne: Wortham Mach'y Co., 517 W. 17th St.

TEXACO, INC.

135 East 42nd St., New York 17, N. Y.

DISTRICT SALES OFFICES

COLORADO
Denver 3: 1570 Grant St., Tabor 5-7261
GEORGIA
Atlanta: 864 W. Peachtree St., W., Trinity 4-9731
ILLINOIS
Chicago 4: 332 S. Michigan Ave., Harrison 7-1920
INDIANA
Indianapolis 1: 3521 E. Michigan St., Fleetwood 7-0371
MONTANA
Butte: 220 N. Alaska St., Butte 2-1201
VIRGINIA
Norfolk 2: 3300 E. Princess Anne Rd., Ulysses 3-7651

THERMEX METALLURGICAL, INC.
Ridgeway Rd., Lakehurst, N.J., Oldfield 7-5781

DISTRICT SALES OFFICE
PENNSYLVANIA
Evans City: Thermex Metallurgical, Inc.; R.D. 1, President 6-1105

THE W. S. TYLER CO.
3615 Superior Ave., Cleveland 14, Ohio

DISTRICT SALES OFFICES
ILLINOIS
Chicago 4: 200 So. Michigan Ave., Wabash 2-0715
PENNSYLVANIA
Philadelphia 7: Philadelphia National Bank Bldg., Locust 3-6055
Pittsburgh 32: 5506 5th Ave., Museum 1-6399
WEST VIRGINIA
Charleston 4: 913 Alynwood Circle, Dickens 4-1834

U

UNITED STATES RUBBER CO., MECHANICAL GOODS DIV.
Rockefeller Center, 1230 Avenue of the Americas, New York 20, N.Y.

DISTRICT SALES OFFICES
COLORADO
Denver: 4800 Colorado Blvd., Dudley 8-2481
GEORGIA
Atlanta: 999 Lee St., S.W. Plaza 5-6631
ILLINOIS
Chicago: 4135 S. Pulaski Rd., Cliffside 4-5700
MARYLAND
Baltimore: 500 North Point Rd., Eastern 7-0085
MICHIGAN
Detroit: 2121 W. Fort St., Tashmoo 6-2121
MISSOURI
N. Kansas City: 16th and Swift Aves., Grand 1-3575
NEW JERSEY
Passaic: 1 Market St., Prescott 7-4'00
PENNSYLVANIA
McKees Rocks: Royal Drive & Graham St., Spalding 1-3500

UNITED STATES STEEL CORP. UNITED STATES STEEL SUPPLY DIV.
208 South LaSalle St., Chicago 4, Ill.

DISTRICT SALES OFFICES
ALABAMA
Birmingham: 912 North 20 St.
ARIZONA
Phoenix: 703 N. 15th Ave.
ILLINOIS
Chicago: 1319 Wabansia Ave.
Moline: 41 Street and Railroad Ave.
MARYLAND
Baltimore: Bush and Wicomico Sts.
MISSOURI
St. Louis: 311 South Sara St.
OHIO
Cleveland: 7105 Bessemer Ave.
OREGON
Portland: 2345 N.W. Nicolai St.
PENNSYLVANIA
Philadelphia (Bala Cynwyd): Rithters Ferry Road and Schuylkill River
Pittsburgh: 1281 Reedsdale St., N.S.
TENNESSEE
Memphis: 1701 Dock St., President's Island
WASHINGTON
Seattle: P.O. Box 3807
WISCONSIN
Milwaukee: 4027 W. Scott Street

UNITED STATES STEEL CORP.
525 William Penn Place, Pittsburgh 30, Pa.

SALES OFFICES
ILLINOIS
Chicago 90: 208 S. LaSalle St.
INDIANA
Indianapolis 6: Room 428, Chamber of Commerce Bldg, 320 N. Meridian St., P.O. Box 408
MARYLAND
Baltimore 2: 300 St. Paul Place
MICHIGAN
Detroit 2: 9-236 General Motors Bldg.
MISSOURI
Kansas City 5: 2706 Power & Light Bldg., 104 W. 14th St.
St. Louis 3: Shell Bldg., 1221 Locust St.
Buffalo 2: 1305 Liberty Bank
OHIO
Cincinnati 1: 1416 Fifth Third Bank Bldg., Fourth & Walnut Sts., P. O. Box 778
PENNSYLVANIA
Cleveland 14: 620 Leader Bldg., 526 Superior Ave.
Philadelphia 3: 1220 Suburban Sta. Bldg., 1617 Pennsylvania Blvd.
Pittsburgh 30: 525 William Penn Place
WISCONSIN
Milwaukee 1: Bankers Bldg., 208 E. Wisconsin Ave., P. O. Box 785

UNION SWITCH & SIGNAL DIV. OF WESTINGHOUSE AIR BRAKE CO.
Swissvale, Pa.

DISTRICT SALES OFFICES
ILLINOIS
Chicago 4: 827 Railway Exchange Bldg., Harrison 7-0800
PENNSYLVANIA
Pittsburgh 18: Churchill 2-5000

UNION WIRE ROPE, ARMCO STEEL CORP.
2100 Manchester Ave., Kansas City 26, Missouri, Benton 1-3100

V

VASCOLOY-RAMET CORP.
Waukegan, Illinois

DISTRICT SALES OFFICES
ILLINOIS
Benton: 704 Election St., GEneral 8-6931
KENTUCKY
Winchester: 2 Jefferson St., PIoneer 4-5626
NEW MEXICO
Carlsbad: 402½ South Main St., TUxedo 5-6537
OHIO
St. Clairsville: 108 Woodrow St., OXford 5-2931
PENNSYLVANIA
Uniontown: 309 W. Berkley GEneva 7-5420
WEST VIRGINIA
Bluefield: 625 Shenandoah Ave., DAvenport 5-8652
Fairmont: 116 Avery St., FAirmont 5077
Pineville: Box 475, Pineville 2351

DISTRIBUTORS
ALABAMA
Birmingham: Crandall Engineering Co., Inc. 601 Tenth St. North
Mobile: Oliver H. Van Horn Co., Inc. 111Beauregard St.
ARKANSAS
Fort Smith: R. A. Young & Son, Inc. 301 South Tenth St.
Little Rock: Lyons Machinery Co., 904 Broadway
Little Rock: Hollis & Co., 330 E. Third St.
COLORADO
Denver: Ralph B. Moore, Inc. 3847 Forest St.
ILLINOIS
Chicago: Acme Mine Supply Co., 111 N. Wabash
Chicago: Coalfield Co., 360 W. Jackson St.
Chicago: Vanguard Equipment & Supply Corp., 231 S. LaSalle St.
Joliet: McLaughlin Mfg. Co.
Lyons: Producers Supply & Engineering Co., Inc. 4226 So. Lawndale Ave.
Sharpsburg: Hill's Welding & Machine, Box 54
INDIANA
Evansville: Shouse-Brill Machinery Co.
Indianapolis: Mobile Drilling Inc. 940 N. Pennsylvania St.
Terre Haute: Frank Prox Co., Inc.
KENTUCKY
Hazard: Delaware Powder Co.
Lothair: Mine Service Co.
Madisonville: Claude L. Humphrey, 240 East View Drive
Paducah: Henry A. Petter Supply Co.
Pineville: Delaware Powder Co.
Winchester: Ace Bit Co., 2 Jefferson St.
NEW MEXICO
Albuquerque: Mine Supply Co., P.O. Box 1775
Grants: Geo. E. Failing, Airport Road
OHIO
Canton: Apex Powder Drilling Co. 1545 Waynesburg Road. S.F.
Nelsonville: Wilson Brothers
Steubenville: The Voto Manufacturers Sales Co. 523-525 North Webster Ave.
Zanesville: Goss Supply Co., 620 Marietta St.
Zanesville: Hutchinson Supply Co., 903 Chester St.
PENNSYLVANIA
Charleroi: Lee-Norse Co.
Hopwood: Reed Brothers Rotary Bit
Indiana: National Mine Service Co., 1260 Maple St.
Kulpmont: Bressi Supply Co., 655 Chestnut St.
Leechburg: Leechburg Supply Co. Lock Box 586
Pittston: Eagen Hardware Co.
Tremont: Tremont Hardware Co.
Uniontown: Tri-State Mine Supply Co. 72 North Gallatin Ave.
Wyoming: James Eagen & Sons
TENNESSEE
La Follette: Tennessee Explosive Corp.
UTAH
Kenilworth: Frank C. Memmott, P. O. Box 154
VIRGINIA
Grundy: Buchanan - Williamson Supply Co.
WEST VIRGINIA
Bluefield: Bluefield Hardware Co.
Charleston: Wm. S. Bolden Co., Inc. Box 4106, 3416 MacCarkle Ave.
Fairmont: Cr-Mar Sales Co., Fair mont Avenue Extension
Huntington: J. H. Fletcher & Co., 707 West Seventh St. P. O. Box 2143
Huntington: Sterling Supply Co., P.O. Box 246 850—7th St., W.
Logan: Logan Hardware & Supply Co., Box 540
Pineville: Williamson Supply Co. Pineville 2701
Shinnston: Erwin Supply Co., Inc., P.O. Box 5
Williamson: Williamson Supply Co.
Weirton: Weirton Ice and Coal Supply Co., 401 Penn Ave.

W

WARNER LABORATORIES
617 First St., Cresson, Pa., Turner 6-7400

WEDGE WIRE CORP.
Gas St., & N. P. R. R., Wellington, Ohio

WEMCO DIV. OF WESTERN MACHINERY CO.
650 Fifth St., San Francisco 7, Calif. Exbrook 7-1717

DISTRICT SALES OFFICES
ARIZONA
Phoenix: P. O. Box 6472, 820 North 17th Ave., Alpine 8-8531
CALIFORNIA
Sacramento: P. O. Box 269, 721 North "B" St., Gilbert 3-2068
MICHIGAN
Niles: P. O. Box 231 Mu4-0066
MISSOURI
Glendale 22: 1012 W. Kirkham, Taylor 2-2955
OHIO
Columbus: 1767 Riverhill Rd., Hu 6-1755
Westerville: 158 Cornell Court, 882-6640
PENNSYLVANIA
Pittsburgh: 530 6th Ave., Express 1-0260
Scranton: 1430 College St., Di 2-8540
WEST VIRGINIA
Charleston 4: 1231 Lyndale Drive, Di 6-2709
CANADA
Ontario, Toronto: 129 Adelaide St., West, 362-3297

WESTINGHOUSE ELECTRIC CORP.
3 gateway Center, P.O. Box 2278, Pittsburgh 30, Pa.

DISTRICT SALES OFFICES
ALABAMA
Birmingham: 1407 Comer Bldg.
Huntsville: 112 Gallatin St.
Mobile: 1511 Merchants Nat. Bank Bldg.
ILLINOIS
Aurora: 901 Main St.
Chicago: Mdse. Mart Plaza
Peoria: 915 N. Adams St.
Rockford: 2115 15th St.
Springfield: 617 E. Adams St.
INDIANA
Evansville: 1253 Diamond Ave.
Fort Wayne: 124 W. Washington
Hammond: 6355 Indianapolis Blvd
Indianapolis: 1560 Stadium Dr.
South Bend: 216 E. Wayne St.
KENTUCKY
Louisville: 332 West Broadway
MISSOURI
Kansas City: Mulberry at 13th St
St. Louis: 411 N 7th St.
OHIO
Akron: 1945 W. Market St.
Canton: 1452 Cleveland Ave. N.W.
Cincinnati: Gwynne Bldg.
Cleveland: The Illuminating Bldg
Columbus: 940 Williams Ave.
Dayton: 32 N. Main St.
Toledo: 245 Summit St.
Youngstown: 25 E. Boardman St.
PENNSYLVANIA
Allentown: 739 Hamilton St.
Erie: 1007 Hess Ave.
Johnstown: 406 Main St.
Philadelphia: 3001 Walnut St.
Pittsburgh: 306 4th Ave.
Wiles-Barre: 267 N. Pennsylvania Ave.
Williamsport: 221 Williamsport Bldg.
TENNESSEE
York: 153 E. Market St.
Chattanooga: Volunteer Life Bldg.
Kingsport: 145 Commerce St.
Knoxville: 605 Burwell Bldg.
Memphis: 825 Exchange Bldg.
UTAH
Salt Lake City: 235 W.S. Temple St.
VIRGINIA
Norfolk: 915 S. 21st St.
Richmond: 4000 West Broad St.
Roanoke: 305 First St., S.W.
WEST VIRGINIA
Bluefield: 704 Bland St.
Charleston: 1206 Kanawha Blvd East
Fairmont: 10th and Beltline
Huntington: 1029 7th Ave.
Wheeling: 12th & Main Sts

WICKWIRE SPENCER STEEL DIV., COLORADO FUEL & IRON CORP.
CORP., Box 232, Palmer, Mass.

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COLORADO
Denver 2: 4950 Colorado Blvd.
Pueblo: P. O. Box 316
ILLINOIS
Chicago 32: 3838 W. 51st
PENNSYLVANIA
Emlenton: P.O. Box 388
Philadelphia 40: 225 W. Erie Ave.
TENNESSEE
Chattanooga 10: P.O. Box 7056
UTAH
Salt Lake City 5: 212 W. 13th St.

WILD HEERBRUGG, INC.
396 Main St., Port Washington, N.Y.

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P.O. Box 2330, Denver 1, Colo.

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White Haven, Pa.

DISTRIBUTORS
ALABAMA
Birmingham 1: Salmon & Co., Inc., P.O. Box 2388, 609 North Ninth St.
KENTUCKY
Madisonville: Kert E. Reed Co., P.O. Box 415
PENNSYLVANIA
Johnstown: Penn Machine Co.
Pittsburgh 8: G. N. Crawford Equipment Co., 6714 Kelly St.
Pittsburgh 19: Penn Machine Co., 905 Porter Bldg.
Pittsburgh 28: James A. Redding, 634 Washington Rd.

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604 DRYDEN STREET
CHARLESTON, W. VA.

ELECTRIC AND MACHINE SUPPLY COMPANY

Largest Supplier of the Best Rebuilt Mining Equipment

BELT CONVEYORS

1—36" Robbins Belt Conveyor, 1,000' centers
1—36" Joy Model "C" Belt Conveyor, 1,080' centers
5—MTB 30 Joy Tandem Belt Conveyors, 1,000' centers, 25, 40 & 50 h.p.
1—30" 97HC Goodman Belt Conveyor, 1,000' centers with 25 h.p. Tandem Drive
4,280'—30" 99-5GT Goodman Belt Conveyor Structure
5—99-5GT Goodman Belt Conveyor Structure
1—30" Shop Constructed Belt Conveyor Drive
8,760'—26" Joy Model "C" Structure
18—26" Belt Conveyor Drives, various makes
1—26" MTB Joy Tandem Belt Conveyor, 1,000' centers

LOADING MACHINES

2—11BU Joy Loaders, 250 V. D.C.
5—8BU Joy Loaders, A.C. & D.C., rebuilt
1—14BU-7RAE Joy Loader, 250 V. D.C.
2—14BU-7RBE Joy Loaders, 250 V. D.C.
3—14BU-7BE Joy Loaders, 250 V. D.C.
3—14BU-3PE Joy Loaders, 250 V. D.C.
8—14BU-2E Joy Loaders, 250 V. D.C., 28" O.H.
3—12BU-9E Joy Loaders, 250 V. D.C., Rebuilt
3—20BU—Joy Loaders, 250 V. D.C., Permissible
1—360 Goodman Loader, on rubber, 250 V. D.C.
6—Long 88 Pig Loaders, 250 V. D.C.
1—24BB Clarkson Loader, 250 V. D.C.
1—Eimco 21 Rock Loader, 220/440 V., A.C., 36" t.g.

CONTINUOUS MINERS

1—3JCM Joy Continuous Miner, 250 V. D.C., Excellent condition

SHUTTLE CARS

5—60E-10 Joy Shuttle Cars, w/Elevators, matched pairs, 250 V. D.C.
9—42E Joy Shuttle Cars, 250 V. D.C.
15—5SC Joy Shuttle Cars, w/Elevators, 250 V. D.C.
17—6SC Joy Shuttle Cars, matched pairs, 250 V. D.C.
4—8SC Joy Shuttle Cars, Elevating Discharge, Permissible Plates, Excellent condition, 250 V. D.C.
15—32E-10 & 32-E-16 Joy Shuttle Cars, Excellent condition, 250 V. D.C.
3—32D Joy Shuttle Cars, complete w/batteries
2—MT66-A45 Jeffrey Shuttle Cars, 250 V. D.C., matched pair, permissible, Excellent condition

CUTTING MACHINES

4—12RB Joy Cutting Machines, 250 V. D.C., Permissible, dual wheels, Bugdusters, 9' bar, Excellent condition
4—11RU Joy Cutting Machines, 250 V. D.C., Permissible, Bugdusters, one completely rebuilt
1—70-URB Jeffrey Cutting Machine, 250 V. D.C., Excellent Condition
1—29U Jeffrey Cutting Machine, 220/440 V. A.C., completely rebuilt, 36" t.g.
12—512 Goodman Cutting Machines, 250 V. D.C., Hydraulically or Manually controlled
1—824 Goodman Slabber, 250 V. D.C.
44—35B and 35BB Jeffrey Cutting Machines, A.C. and D.C.
5—7AU Sullivan Cutting Machines, 250 V. D.C.
6—7B Sullivan Cutting Machines, 250 V. D.C.
16—11B Sullivan Cutting Machines, 35 & 50 h.p., 250 V. D.C.
15—12AB and 12AA and 112AA Goodman Cutting Machines, 250 V. D.C.
5—212AA Baby Goodman Cutting Machines, 250 V. D.C.
1—712CJ Goodman Cutting Machine, 250 V. D.C.

PREPARATION EQUIPMENT

1—4 Cell Jeffrey Baum Jig Washer, complete, 300 t.p.h. capacity
1—Simon Carver Heavy Duty 2 compartment Baum Jig, 400 t.p.h. capacity
1—Daniels Heavy Media Washer
1—48" CMI Centrifugal Dryer
1—Heat Dryer, complete
1—36" x 130' Hot Material Handling Belt, Excellent
4—7' x 15' Single Deck Diester Tables
1—36" x 33" Marion Double Roll Crusher
1—30" x 36" Jeffrey Double Roll Crusher, Like New
1—30" x 30" Link Belt Double Roll Crusher
1—24" x 50" Pa. Single Roll Crusher
3—24" x 24" Jeffrey Single Roll Crusher
1—2' x 4" Williams Pulverizer
1—18" x 24" McClanahan & Stone Single Roll Crusher
1—6' x 14' Single Deck Allis-Chalmers Low Head Vibrator, Like New
1—5' x 12' Allis-Chalmers Triple Deck Low Head Vibrator
1—5' x 12' Allis-Chalmers Ripl-Flo Double Deck Vibrator
1—4' x 12' Hewitt Robbins Vibrex Screen, Triple Deck
5—4' x 7' Jeffrey Traylor Double Deck, Vibrators
2—4' x 7' Jeffrey Traylor Single Deck Vibrators
1—3' x 4' Single Deck Gyro Vibrator
1—3' x 8' Low Head Vibrator
1—30" x 72" Jeffrey Traylor Double Deck Vibrator
2—Magnetic Separators, complete
1—Set Jeffrey Dewatering Screens
4—Scraper Conveyors of various sizes
15—Drag Conveyors of various sizes
1—970' Jeffrey Rope and Button Conveyor
11—Boom Hoists from 1 ton to 5 ton
We can construct loading booms and tipple belt in any size.

MISCELLANEOUS TRACKLESS EQUIPMENT

1—WK-83R Joy Compressor, 250 cu. ft.
1—WL-82 Joy Compressor, 125 cu. ft.
2—T2-5AE & T2-2E Joy Machine Trucks
2—T1-4G Joy Machine Trucks, 220 V. A.C.
1—Lot 9J, 10J, 23J and 24J Motors

LOCOMOTIVES 250V D.C.

3—20 Ton Jeffrey MH77 Locomotives 42" & 48" t.g.
1—15 Ton HM828 G. E. Locomotive, 90 h.p. units, 44" O.H., 48" t.g., Excellent
11—13 Tons Locomotives, 250 V., any guage
1—12 Ton 29B Goodman Locomotive, 40" O.H.
10—10 Ton Locomotives, 250 V., any gauge
18—8 Ton Locomotives, 250 V., any guage
28—6 Ton Locomotives, any guage
4—6 Ton Jeffrey MH150 Locomotives
12—6 Ton MH88 Jeffrey Locomotives
11—5 Ton Locomotives, 250 V.
17—4 Ton Locomotives, 250 V., any guage

BATTERY LOCOMOTIVES

5—7 Ton Atlas Locomotives
2—6 Ton Mancha Locomotives, 36" t.g., 47" O.H.
1—4 Ton G.E., 48" t.g.
1—4 Ton Mancha Locomotive, 48" t.g.
1—4 Ton Ironton Locomotive, complete w/Charger, 44" t.g.
1—Set Gould Locomotive Batteries, 48 cell

CHAIN AND SHAKER CONVEYORS

20" Joy Chain Conveyors, A.C. & D.C., Permissible
15" Chain Conveyor Drives, A.C. & D.C., Permissible
15" Long Chain Conveyors, A.C. & D.C.
12" & 15" Jeffrey Chain Conveyors
12" Goodman Chain Conveyors
PT12 Long Piggyback Conveyors
PT12-B Long Piggyback Conveyors
Goodman G12½, G15 & G20 Shaker Conveyor Drives
Joy Ladel UN17 Shaker Conveyor Drives
Goodman Power Duckbills & Duckbill Hoists

SUB STATIONS & TRANSFORMERS

1—300KW Westinghouse Stationary Rectifier, completely rebuilt
1—Westinghouse A.C. Sub Station, 4500KVA 6900/2300, complete w/boards, Excellent
3—300KW M. G. Sets
5—200KW M. G. Sets
3—200KW, HCC-6-1200 G. E. Rotary Converters, Automatic
2—150KW G.E. Rotary Converters, w/Transformers
1—150KW Westinghouse Rotary Converter, Completely Automatic
18—150KW M.G. Sets of various makes & voltages
2—100KW M.G. Sets
1—100KW Westinghouse Generator, 250 V. D.C. connected to Buda Diesel Engine, complete w/boards
2—100KW Generators, w/671 G.M. Diesel
1—90KW Generator, w/671 G.M. Diesel, Excellent
1—75KW Generators, w/10019 Diesel Engine
1—85KW Generator, w/75 h.p. G.M. Diesel w/ITE Automatic Control Board
1—100KVA Gasoline Alternator Unit
1—50KW M.G. Set, 125 V., D.C., 1200 rpm
2—Armatures for 200 KW Rotary G.E., type HCC
2—600 & 800 Auto Transformers
166—Transformers from 1½ to 800KVA, list sent upon request

RAIL AND WIRE

1,585 —Tons 30, 40, 56, 60, 70 & 100 lb. Relaying Rail
400'—500,000 CM Bare Copper Feeder Cable
15,000'—2/0, 3 cond. Copper Cable, Ins.
37,600'—1/0 Solid Copper Highline Wire
15,000'—#1 Solid Copper Highline Wire
2,643'—#2 Stranded Copper Highline Wire
160,400'—#2 Solid Copper Highline Wire
1,595'—#4 Solid Copper Highline Wire
5,000'—2/0, 3 cond. Anhydrex & Lead Covered Transmission Cable
6,000'—4/0, 3 cond. Neoprene Jacketed Cable
1,800'—9 Section Figure 8 Trolley Wire
Several thousand feet #2, #3 and #4 approved type machine cable, 3 & 4 conductor

MINE CARS

50—36" t.g. Phillips Clay Cars, 50" O.H., Excellent
40—36" t.g. Drop Bottom Cars
128—42" t.g. End Dump Cars, various makes
253—42" t.g. S. D. Drop Bottom Mine Cars
50—42" t.g. A.C.F. Drop Bottom Cars
140—44" t.g. Drop Bottom Cars, various sizes
356—44" t.g. End Dump Cars, various sizes
82—48" t.g. S. D. Drop Bottom Cars
259—48" t.g. A.C.F. Drop Bottom Cars
6—48" t.g. Man Trip Cars
2—56½" t.g., 3 ton, 4 wheel push trucks New

MISCELLANEOUS

1—TD9 International Hi-Lift
1—Canton Track Cleaner, Excellent
15—HKL, HKG, HKC, HL & CR Brown Fayro & Sullivan Hoists
49—Air Compressors of various sizes
57—Auto Starters from 3 h.p. to 100 h.p.
70—Hoists from 1½ to 800 h.p.
6—Shop constructed Jeeps, track mounted
7—Hydraulic Schroeder Coal Drills
93—Coal Drills, various makes and sizes
94—Pumps from ¾" to 4500 GP
1—Pomona Deep Well Pump
1—14" Centrifugal Slurry Pump
33—Battery Chargers, various voltages
17,270'—Pipe: Galvanized, Plastic & Cast Iron
49—Room Blowers—Brown Fayro & Jeffrey
22—Mine Fans from 30" to 9' Hi Pressure
15—Rock Dusters up to 30 h.p.
3—Phillips Machine & Shuttle Car Carriers, 36" to 48" t.g.
1—42 Ton Richards Truck Scale, 10' x 25' deck
556—Stationary Motors—½ to 800 h.p., A.C. and D.C. (List of motors available upon request)
800'—4" Plastic Pipe
11,200'—3" Plastic Pipe

ALL INQUIRIES WILL BE ANSWERED PROMPTLY

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BRONSTONE CLAY • GORDON STAFFORD

MOUNTAIN STATE EQUIPMENT COMPANY

WHERE QUALITY IS YOUR BONUS

CALL US FOR YOUR MINING NEEDS, WE BUY, SELL OR TRADE

AC EQUIPMENT

2—14BU Joy Loading Machines
2—14BU-7BG Joy Loading Machines
3—11BU-10APH Joy Loading Machines
1—35L Jeffrey Cutting Machine
1—12G-3 Goodman Cutting Machine
3—7B Sullivan Cutting Machines
2—4JCM Joy Continuous Miners, 440 Volts AC.
1—T2-5APE Joy Machine Truck

LOADING MACHINES, 250 Volts DC

2—14BU-7RBE Joy Loaders, excellent condition.
1—14BU-7RAE Joy Loader
1—14BU-7CE Joy Loader, excellent condition.
1—14BU-7BE Joy Loader
6—12BU-9E Joy Loaders
10—11BU-10APE Joy Loaders, completely modern.
4—8BU Joy Loaders
3—7BU Joy Loaders
1—18HR Joy Loader
3—360 Goodman Loaders

SHUTTLE CARS, 250 Volts DC

7—10SC Joy Shuttle Cars, right & left hand drive.
2—60E-10 Joy Shuttle Cars, modern.
2—6SC-7E Joy Shuttle Cars, modern.
1—6SC-5E Joy Shuttle Car, modern.
2—42E-18 Joy Shuttle Cars, completely modern.
1—32E-7 Joy Shuttle Car.
2—10SC-1F Joy Shuttle Cars, 500 Volt DC.
3—Model 48 TorKar Shuttle Cars.

CUTTING MACHINES, 250 Volts DC

1—11RU Joy Cutting Machine—used 12 months.
6—10RU Joy Cutting Machines—excellent
3—512 EJH & EJ Goodman Cutting Machines.
2—29UC Jeffrey Universal Cutters.
2—29LC Jeffrey Top Cutters.
5—35B Jeffrey Cutters.
6—35BB Jeffrey Cutters.
5—35L Jeffrey Cutters.
1—7AU Sullivan Cutter.

RECTIFIERS, 275 Volt DC, Primary 2300/4160

1—300 KW General Electric Portable Rectifier
1—400 KW American Selenium Rectifier

MOTOR GENERATORS—250 & 275 Volts DC

1—300 KW, G.E. MG Set, primary 2300/4160, 1200 RPM
1—G.E. 200 KW MG Set, primary 2300/4160, 1200 RPM
1—200 KW Westinghouse MG Set, primary 2300/4160, 1200 RPM
1—150 KW Westinghouse MG Set, primary 2300/4160, 1200 RPM
1—150 KW G.E. MG Set, primary 2300/4160, 1200 RPM
1—150 KW G.E. MG Set, primary 440 Volt AC, 1200 RPM
1—300 KW Westinghouse MG Set, primary 2300/4160, 1200 RPM
3—50 KW G.E. MG Sets, primary 2300/4160, 1200 RPM

DIESEL PLANTS

1—75KW Diesel Gen. Set, 250 V. DC with 671 GM Engine.
1—90KW Diesel Gen. Set, 250 V. DC with 671 GM Engine.
1—D13000 Caterpillar Diesel Gen. Set with 75KW, 220 V. AC Generator.
1—100 KW Superior Diesel Gen. Set, 275 V. DC
1—75KW Buda Diesel Gen. Set, 275 V. DC.

ROTARY CONVERTERS, 275 Volts DC, Primary 2300/4000

1—300 KW Westinghouse, Pedestal Type
1—100 KW G.E. HCC-6, 1200 RPM, Pedestal Type
1—200 KW G.E. HCC-6, 1200 RPM, Pedestal Type

BELT CONVEYORS

1—36″ Barber Greene Lattice Frame Conveyor, 150′ long.
1000′—26″—97C Goodman Belt Conveyor, complete.
1000′—26″—97C Goodman Belt Structure, only.
2—MTB-30 Joy Belt Head & Tails, only.

CHAIN CONVEYORS

1—350′ LaDel Conveyor Line, complete
1—300′ Joy Pans & Chains, complete.
5—61AM Jeffrey Conveyors—300′ long.
1—61HG Jeffrey Chain Conveyor, 40′ long.
1—Jeffrey 300′—15″ Chain Conveyor.

LOCOMOTIVES

1—G.E. 6 Ton Locomotive w/Reel, 36″ gauge.
1—1030 Goodman Locomotive, 24″ high, 44″ gauge.
1—13 Ton Goodman—Type 81A04T, modern.
1—Goodman 13 Ton 136B-0-4-B w/75 HP Motors.
2—13 Ton Jeffrey Locomotives
1—Goodman 5 Ton 3012 with 50 HP Motor.
4—8 Ton 132AK42-48R Goodman w/2—50 HP Motors.
1—8 ton 32-0-4-T Goodman with 2—50 HP Motors.
1—8 ton LM2-8-T.DD G.E. with 2—50 HP Motors.
3—6 ton LM2-T-6MM G.E. with 2—35 HP Motors.
2—6 ton LM2-4-6-11 G.E. with 2—35 HP.
3—Greensburg Monitors complete charging equipment.

ELEVATING CONVEYORS

5—PL11-16RPE Joy Elevators.

CRUSHERS

1—36″x36″ Double Roll Crusher with 100 HP Motor.
1—Robins 36″x36″ Double Roll Stoker Crusher.
1—Pa. Single Roll Crusher—24″x40″
1—McNally Pittsburg 24″x36″ Stoker Crusher w/new segments.
1—American Pulverizer 26″x42″, 200 tph—#AC-3B
1—American Pulverizer 24″x24″, 30 tph—#WC-24
1—American Pulverizer 36″x30″, 160 tph—#AC-3
1—American Pulverizer 24″x30″, 75 tph—#WC-30
1—American Pulverizer 36″x30″, 100 tph—#AC-30-S.

MINE CARS—42″ GAUGE

19—Sanford Day 3 Door Drop Bottom Cars, 36″ high.
24—AC&F 3 Door Drop Bottom Cars, 34″ overall height without 10″ sideboards
173—AC&F Drop Bottom Cars, 48″ high, new condition.
5—Mantrip Cars.

COMPLETE FOUR TRACK TIPPLE

1—CMI 48″ Dryer with motors, drives, belt, etc., screen cloth 1/16″ opening, capacity 90 tph.
1—Coppus Ventair Blower.
5—8x16 Allis Chalmers Pumps with motors.
1—16x14 Allis Chalmers Centrifugal Pump, complete.
1—Roberts & Schaefer Eleptic Vibrator.
1—Roberts & Schaefer Air Drying Plant, complete.

MOBILE EQUIPMENT

1—Koehring Heavy Duty Crane
1—Shovel Dipper Stock for same, 16′ long, 3/4 yard dipper.
1—Hough Pay Loader, Model HF & HFH.
1—1950 International Flat Bed Tandem Truck.
1—Allis Chalmers Tractor Hi-Left.
1—Caterpillar Tractor D-6, 60″ Gauge.

MACHINE TRUCKS, 250 Volts DC

2—T2-5APE Joy Machine Trucks.

COAL DRILLS

25—CP-472 Electric Coal Drills, 250 Volts DC.
5—CP-572 Coal Drills, 250 Volts DC.
10—Chicago Pneumatic Little Giant Coal Drills, 220 Volts AC.
2—CD-22 Joy Coal Drills, 250 Volts DC.
5—Dooley Self-Propelled Drill Trucks, twin-armed, track or rubber.

ROOF BOLTING MACHINES

3—Fletcher Roof Bolting Machine w/dust collectors.
1—RBD-30 Chicago Pneumatic Roof Drill.

HOISTS

10—Vulcan-Denver #11½ Material Hoists w/motors.
1—Brownie Hoists, 5 HP, AC
2—Joy CHD Hoists, 10 HP
1—Brownie Hoist, HKO, good condition.

COMPRESSORS

2—Acme Self-Propelled Air Compressors, Model 168.

ROCK DUSTERS

2—Manson 24-S Wet Rock Dusters.
2—MSA Rock Duster, 25 H.P. Track
2—MSA Bantam Rock Dusters, rubber tired.
1—American Mine Door Rock Duster, 22″ high.

FANS

1—Jeffrey 8H-42 Aerodyne Fan complete w/motor, "V" belt & tubing.
1—Jeffrey 8H-60 Aerodyne Fan complete w/G.E. 100 H.P., 440 V. AC Motor & Auxiliary Ford Industrial Power Unit.

CONTINUOUS MINERS

2—Goodman Type 402 Continuous Boring Machines, 250 Volts DC, Serial No.'s 524 & 536, USBM Permissible. Excellent, modern machinery.
2—1CM Joy Continuous Miners, 250 Volts DC.
1—Goodman Continuous Boring Machine, 440 Volts AC, 250 HP, can be converted to twin borer.
1—5JCM Joy Continuous Miner with self-tramming and extensible belt, 440 Volt AC complete with 1000 ft. of structure and belting.

MISCELLANEOUS

1000—40 lb. Steel Ties, 42″ gauge.
20—40 lb. Switches, complete.
20—60 lb. Switches, complete.
1—American Mine Door Automatic Electric Throw Switch.
3—2300/4160 Y—230-115 Volt—200 KVA G. E. Transformers.
3—2300/115/230 Volt—15 KVA G.E. Transformers.
1—Nolan Portafeeder, complete.
1—Canton Track Cleaner, 42″ gauge.
1—75 ton Fairbanks Morse Truck Scale.
1—5″ Pomana Deepwell Pump
1—42″ gauge Phillips Carrier.
1—Manson Mine Jeep, 40″ gauge.
2—Lincoln 300 amp. MG type DC Welders
2—Hobart 300 amp. MG Type DC Welders
4—Guyan Resistance Bonder Welders.
495 ft.—1/9 Conductor 5000 Volt Rubber Covered Cable w/ground.
2000 ft.—2/0-3 Conductor 2300 Volt Rubber Covered Bore Hole Cable.
3000 ft.—4/0-3 Conductor 5000 Volt Trench Cable.
4000 ft.—2/0-3 Conductor 5000 Volt Trench Cable.
AC and DC motors ranging from 1 to 100 H.P.
Complete inventory of new parts for 10SC, 10RU and 11BU Joy Equipment. Hundreds of other items such as pumps, motors, armatures, locomotive trucks, wheel units, hydraulic pumps, conveyor chain, cat chains, tipple draglines, etc., too numberous to list.

ALL EQUIPMENT LISTED AND HUNDREDS OF OTHER ITEMS ARE IN STOCK AND MAY BE INSPECTED AT OUR SHOP AND EQUIPMENT YARDS LOCATED AT RALEIGH, WEST VIRGINIA AND O'FALLON, ILL.

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R. E. Kamm, Summersville, Res. 4281

Roy Fairchild, Res. ME 2-5881
J. J. Mahoney

YOUR ATTENTION, PLEASE

THE COLORADO FUEL AND IRON CORPORATION is closing its FREDERICK COAL MINE

located at Valdez, Colorado, 15 miles west of Trinidad, Colorado on State Highway No. 12 and plans to dispose of its equipment.

This equipment consists mainly of the following:

HAULAGE

500—Steel solid bottom mine cars, 125 cu. ft. water level, automatic couplers, 36" track gauge.
15—Trolley locomotives—Westinghouse and Jeffrey 10 to 15 tons, 500 volt D.C.
17—Goodman 4 ton, permissible storage battery locomotives with batteries, All 36" gauge.

MINING

27—Goodman Type G20 shaker conveyors with 500 volt D.C. motors and some duckbills.
22—Goodman Type 512 shortwall mining machines with 500 volt D.C. motors and 12 No. 1215 power bug dusters.
44—Chicago Pneumatic electric coal drills Model 574, 500 volt D.C. motors and No. 1045 post assemblies.
Miscellaneous lot of jackhammers, stopers, paving breakers and drifters.
5—Sullivan WL 60 and WK 26 portable compressors with 500 volt D.C. motors.
14—Sullivan single drum room hoists, 1540 lb. rope pull, 5 hp, 550 volt D.C. motors.
15—Miscellaneous hoists.

VENTILATION

Jeffrey Aerodyne exhaust fan Model 8H72, belt drive, 125,000 c.f.m. at 900 r.p.m.
1—Jeffrey 2' x 5' exhaust fan with steel housing.
1—Jeffrey 2 1/2' x 6' exhaust fan.
9—Buffalo 2M blowers with 3 h.p., 500 volt D.C. motors.

DRAINAGE

8—Triplex pumps, 50 g.p.m., 10h.p., 500 volt D.C.
8—Plunger pumps, 25 g.p.m., 5 h.p., 500 volt D.C.
8—Air driven pumps.
Water lines and fittings.

MISCELLANEOUS

2900 tons (approx.) 25 lb. and 60 lb. rail, fittings and turnouts.
Air lines and receivers
Tipple equipment
Shop equipment
Mine supplies

ELECTRICAL

1—Westinghouse portable ignitron rectifier 300 K.W., 2200 volt A.C. to 575 volt D.C.
1—General Electric rotary converter Type TC-300-1200, 300 K.W., 1200 r.p.m. 2200 volts A.C. to 550 volts D.C.
3—Allis-Chalmers 200 K.W. motor-generator sets 440 volts A.C./550 volts D.C. and control equipment.
18—General Electric 10 h.p. motors, Type CVC & RC 550 volt D.C., 900 r.p.m.
8—General Electric 5 h.p. motors, Type MC 550 volt D.C., 1800 r.p.m.
13—Crocker Wheeler 5 h.p. motors, Type SCM, 550 volt D.C., 1600 r.p.m.
8—General Electric 3 h.p. motors, Type B 500 volt D.C., 3500 r.p.m.
6—G.E. 200 K.V.A. single phase transformers 22,000 volts A.C. to 440 volts A.C.
6—G.E. 150 K.V.A. single phase transformers 22,000 volts A.C. to 440 volts A.C.
10—G.E. 75 K.V.A. single phase transformers 22,000 volts A.C. to 440 volts A.C.
6—G.E. 15 K.V.A. single phase transformers 22,000 volts A.C. to 440 volts A.C.
4 miles 22,000 volt, 3 phase, surface power line and accessories

The above equipment will be available for inspection by prospective buyers until August 15, 1961 and offers are invited on any and/or all of the items. Owner reserves the right to refuse any offer. For any further information please contact:

THE COLORADO FUEL AND IRON CORPORATION

FREDERICK MINE, VALDEZ, COLORADO • Phone Trinidad—Victor 6-2601

HEAVY EXCAVATION EQUIPMENT

DRAGLINES, SHOVELS, CRANES, DRILLS, TRUCKS

9-W B.E. Elec. Drag. 200', 8 yd. or 160', 10 yd.
9-W B.E. Diesel Drag. 165', 12 yd.
7-W B.E. Diesel Drag. 140', 7 yd.
7400 Marion Diesel Drag. 175', 13 yd.
625 Page Diesel Drag. 150', 10 yd.
631 Page Elec. Drag. 200', 8 yd.
621-S Page Diesel Drag. 125', 7 yd.
183-M Marion Diesel Drag. 130', 8 yd.
200-W B.E. Diesel Drag. 125', 6 yd.
2400 Lima Elec. Drag. 130', 6 yd.
2400 Lima Diesel Drag. 130', 6 yd.
7200 Marion Diesel Drag. 135', 5 yd.
4500 Manitowoc Drag. 120', 5 yd. & 140', 4 yd.
120-B B.E. Elec. Drag. 115', 5 yd.
111-M Marion Drag. 100', 4 yd.
1055 P&H Diesel Drag. 80', 4 yd.
1601 Lima 4 yd. Shovel/Drag
1201 Lima Drag. 85', 3 yd.
3900, 3500 & 3000 Manitowoc Cranes
5560 Marion 26 yd. Elec. Shovel
5323 Marion 18 yd. Elec. Shovel
190-B B.E. 8 yd. Elec. Shovel
151-M Marion 7 yd. Elec. Shovel
1600 P&H 6 yd. Elec. Shovels
170-B B.E. 6 yd. Elec. Shovel
4161 Marion 6 yd. Elec. Shovel
2400 Lima 6 yd. Std. H. L. Shovels
120-B B.E. & 4121 Marion 4 yd. Elec. Shovels
4500 Manitowoc 5 yd. H. L. Shovel
1055 P&H 3 yd. H. L. Shovel
1201 Lima 3½ yd. Standard Shovel
111-M Marion Standard & H. L. Shovels
3500 Manitowoc Standard & H. L. Shovels
54-B B.E. Standard & H. L. Shovels
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3—Joy 14BU 9AE Super Loaders—26″ Hi—New 1958.
2—Joy 14BU Loaders, low pedestal, 7AE, 1956 & 57.
4—Joy 14BU Loaders, medium pedestal, 7RBE.
2—Joy 14BU 7CE high pedestal loaders.
4—Joy 14BU 3PE Loaders.
2—Joy 12BU Loaders complete with Piggybacks.
2—Joy 12BU Loaders, 9E, latest type, 250 V. DC.
3—Joy 12BU Loaders, 220/440 Volt AC.
1—Joy 20BU Loader, latest type.
4—Joy 11BU Loaders, latest type.
1—Joy 8BU Loader, 34″ overall height.
1—Joy 8BU Loader, 220 V. AC.
1—Joy curved Bar Head for 14BU, complete.
6—Reliance 24-J Motors, 7½ H.P.
4—Reliance 38-J Motors, 10 H.P.
4—Reliance 40-J Motors, 15 H.P.
20—9-J Motors, 4 H.P. Reliance.
2—Goodman 660 Loaders on Crawlers 440 V. AC., like new.
1—Goodman 660 Loader on Crawlers, excellent 250 V. DC.
1—Goodman 665 Loader on Crawlers, latest type 250 V. DC.
1—Goodman 865 Loader, 26″ hi. Rebuilt. 250 V DC.
4—Joy 8SC Shuttle Cars, rebuilt.
5—8SC Shuttle Cars, as removed from service.
4—Joy 6SC Shuttle Cars, rebuilt, latest type.
6—Joy 6SC Shuttle Cars, as removed from service.
1—Joy 5SC Shuttle Car. Excellent.
2—Joy 32E9 Shuttle Cars.
2—Joy 32E10 Shuttle Cars, rebuilt.
6—Joy 32E15 Shuttle Cars, rebuilt.
4—Joy 32E16 Shuttle Cars, rebuilt.
10—Joy 42E16 Shuttle Cars, rebuilt and as is.
1—Joy CD-22 Drill, on rubber, like new.
6—Joy T-2-5 low pan Crawler Trucks, rebuilt.
1—Joy T-2-6 low pan Crawler Truck with reel.
2—Joy T-1 Standard Crawler Trucks, 220 AC.
1—Joy T-1 Standard Crawler Truck, 250 DC.
4—Joy 11-B Cutting Mach., like new, 35 & 50 H.P.
4—Joy 7-B Cutting Machines, like new, 250 and 500 Volt.
4—Goodman 212 Cutting Machines, 19″ high.
2—Goodman 212 Cutting Machines, 17″ high.
2—Goodman 412 Cutting Machines, 19″ high.
1—Goodman Machine on Crawler, 31″ high. All hydraulic.
6—Goodman 512 Machines with Bugdusters. Rebuilt and as removed from service.
6—Goodman 612 Cutting Machines, 250 and 500 V.
1—Jeffrey 70 URB rubber tired Cutter, Universal head, perfect condition.
1—Goodman 2410 Rubber Tired Cutter, Universal head, like new.
2—Joy 11RU Rubber Tired Cutters with Bugdusters. Universal heads, dual tires, like new, 250 V. DC.
1—Joy 10RU Rubber Tired Cutter, Universal head, 220/440 V. A.C. Perfect.
4—Joy 10RU Rubber Tired Cutters, Universal head, 250 V. D.C. Rebuilt or as is.
6—7AU's on track. Universal head.
2—Jeffrey 29UC Cutting Machines, Universal head, cuts anywhere in seam, 38″ high, on Crawlers, 250 volt D.C.
4—Jeffrey 29LC on Crawlers, rebuilt and as removed from service.

LOCOMOTIVES

1—Goodman 6 ton, 93-A, 27″ high, armor plate frame.
1—Jeffrey 15 ton MH-77 Locomotive, armor plate frame.
7—Jeffrey, 13 ton, Type MH-110, 30″, 42″, 44″ ga.
2—Jeffrey, 10 ton, type MH-110, 42″ and 44″ ga.
2—Jeffrey, 10 ton, type MH-78, 42″ and 44″ ga.
2—Goodman 8-30 and 10-30 Locos., 26″ above rail.
1—Jeffrey MH-150, 6 ton, 26″ overall height, rebuilt with reel.
12—Jeffrey, 6 ton, type MH-88, 42″, 44″ and 48″ ga.
4—Jeffrey, 8 ton, type MH-100 2½″ armor plate frames.
3—Jeffrey, 4 ton, type MH-96, 42″, 44″, 48″ ga.
1—G.E., 4 ton, type 825 Locomotive, 22″ high.
10—G.E., 6 ton, types 801, 803, 821 Locomotives, 42″, 44″ and 48″ ga.
1—G.E., 8 ton, type 822 Locomotive, 44″ ga.
3—G.E., 10 ton, type 809 Locomotives, 42″, 44″ and 48″ ga.
2—G.E., 13 ton, type 829 Locomotives, armor plate frames.
1—Goodman 91A Locomotive, 8 ton, 26″ overall height.
2—Goodman, type 33, 6 ton, 44″ and 48″ ga.
3—Westinghouse, type 902, 4 ton, 42″ and 48″ ga.
1—Atlas Battery Locomotive 36″ ga.
1—Atlas Trolley Locomotive, 4 ton, 24″ high.
2—Westinghouse, type 904, 6 ton, 44″ and 48″ ga.
2—Westinghouse, type 906, 44″ and 48″ ga.
2—Westinghouse, type 907, 10 ton, 44″ & 48″ ga.
3—Westinghouse 908, 13 ton, Locomotives, 42″ & 48″ ga.
8—Jeffrey MH-78 Locomotive Units, cheap.
4—Jeffrey MH-88 Locomotive Units, real bargains.
6—Jeffrey MH-100 Locomotive Units, reasonable.
3—Plymouth Diesel Locomotives, 8 and 10 tons, 42″ and 44″ ga.
Locomotive Trucks & Spare Armatures for the above.

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1—All Steel 5 Track Tipple, new 1957, complete with washer, silo, oil treating system, all bolted construction.
1—Complete Five Track Tipple with Washers and Air Tables.
1—Complete stoker plant, all steel.
2—Complete tipples, 3 & 5 track, steel and wood.
3—Cleaning Plants, 1 Ea. McNally, Roberts and Schaefer, Jeffrey, Washers and Air-Flo Tables.
4—Complete Aerial Trams for coal or refuse.
3—Complete Rope and Button Lines.
2—Monitor Lines complete with Drums, excellent.
1—Allis-Chalmers 5′ x 12′ Rippflo Vibrator.
1—Allis-Chalmers 4′ x 12′ Low-Head Vibrator.
1—Robins Gyrex Vibrator, 4 x 10.
10—Belt and Apron type Loading Booms.
6—Shaker Screens.
1—Robins Car Shakeout.
1—Gundlach Crusher, like new.
20—Crushers, various sizes—Jeffrey, Link-Belt, McLanahan & McNally.
4—Mine Scales, 10 & 20 ton.
5—Truck Scales, 25 to 40 ton, late type.
Feeders, Belt and Drag Conveyors, Car Retarders.

CUTTING MACHINES

1—Joy 10RU Rubber Tired Cutter, Universal head, 220/440 volt A.C. Perfect.
3—Joy 10RU Rubber Tired Cutters, Universal head, 250 V. D.C. As is or rebuilt.
2—Joy 11RU Rubber Tired Cutters, 250 V. D.C.
1—Goodman 2410 Rubber Tired Cutter, Universal head, new 1956. Excellent.
2—Jeffrey 29UC Universal Machines on Crawlers.
1—Goodman on Crawlers, 31″ overall height.
4—Baby Goodman 212's, rebuilt, 250 V. D.C.
2—Goodman 312 Cutting Machines, 17″ high.
3—Goodman 412 Cutting Machines, 19″ high.
6—Goodman 512's, with Bugdusters, like new.
4—Goodman 512's, rebuilt, or as removed from service.
6—Goodman 612's—250 & 500 Volt.
3—Goodman 112's, 220/440 V. A.C.
4—Joy 7-B Cutting Machines, 250 and 500 Volt.
4—Joy 11B Cutting Machines, rebuilt, 35 & 50 H.P.
6—7AU's, on track, Universal Head.
10—Goodman 12AA's and 112AA's, 250 V. D.C.
2—Goodman 324 Slabbers.
2—Goodman 724 Slabbers.
2—Goodman 824 Slabbers.
6—Jeffrey 35L's, like new, 250 V. D.C., 17″ high.
2—Jeffrey 35L's, on low vein trucks.
2—Jeffrey 35L's, 220/440 A.C.
3—Jeffrey 35BB's, 220/440 A.C.
15—Jeffrey 35B's and 35BB's 250 V. D.C.
2—Jeffrey 29B's on track.
10—Jeffrey 29C's, track mounted.
2—Jeffrey 29L's, on Crawlers. Excellent.
4—Sullivan CE7, 220/440 V. A.C.

CONVEYORS

2—Joy 1200′ Belt Conveyors, 30″. "Limberroller," like new.
1—Goodman 97HC 30″ Rope Belts, 1,000′ perfect. With or without rubber.
4—Jeffrey 52-B tandem drive 30″ and 26″ Belt Conveyors, 600′ to 2000′.
1—Jeffrey 52-B tandem drive 26″ Belt Conveyor.
1—Joy 30″ Underground Belt Conveyor. Excellent.
1—Goodman 97-C, 30″ tandem drive.
1—Robins 36″ tandem drive, with or without motor.
5,000′ 52-B Belt Structure, 30″.
1,000′ Conveyor Belt, 42″.
1,500 Conveyor Belt, 36″.
2,000′ Conveyor Belt, 30″.
1,000′ Conveyor Belt, 26″.
8—Jeffrey 61AM 12″ Chain Conveyors, 300′.
2—61EW Elevating Conveyors.
2—61WH 15″ Room Conveyors, 300′.
2—Joy 15″ Room Conveyors, 300′.
2—Joy 20″ Conveyors, 300′.
4—Joy Ladel UN-17 Shakers.
10—Goodman G-12½ and G-15 Shakers.
1,000′ Goodman 18″ Flat Belt Conveyors, tandem drive any length. Perfect.

CONVERTERS AND DIESEL PLANTS

2—500KW G.E. Stationary Rectifiers.
4—1,000KW Stationary Rectifiers.
2—100KW, G.E. TCC-6's, 275V., Rotary Converters.
1—150KW, G.E. HHC-6, 275 V., Rotary Converter.
1—150KW, 6 phase, Allis-Chalmers Rotary Converter, 275 V. D.C.
2—200KW G.E. HCC-6's, Rotary Converters, 275 V. D.C. Steel frames. Newly rewound.
3—300KW G.E. HCC-6's, Rotary Converters, 275 V. D.C. Like New.
2—300KW Westinghouse, 6 phase, Rotary Converters, 275 V. D.C.
2—500KW West. Rotary Converters, 275 V. D.C.
1—200KW Westinghouse Rotary Converters, 275 V. D.C. Newly rewound.
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1—100KW MG Sets, 275 V. D.C.
6—150KW MG Sets, G.E. and West., 275 V. D.C.
2—200KW MG Sets, West., rebuilt, 275 V. D.C.
1—200KW MG Set, G.E., perfect, 275 V. D.C.
2—300KW G.E. MG Sets, like new.
3—300KW Westinghouse MG Sets, 275 V., rebuilt.
1—300KW Westinghouse, 600 volt MG Set, rebuilt.
2—300KW Westinghouse, 600 volt, 6 phase, Rotary Converters.
2—500KW Westinghouse, 600 volt, D.C., 6 phase, Rotary Converters.
2—500KW HCC-6's, Rotary Converters, 6 phase, 600 V. D.C.
3—GMC-671 Diesels with 75 & 110KW, 250 V. D.C. Gen.
1—GMC-471 Diesel with 60KW, 250 V. D.C. Gen.
1—100KW Natural or LP Gas Engine with Generator.

LOADING MACHINES

16—Joy Loaders, 14BU, 12BU, 8BU, 11BU, 20BU.
5—Joy 12BU9E Loaders, 220/440 V. A.C. Excellent.
3—Joy 12BU9E Loaders, latest type.
2—Joy 12BU with Piggyback Conveyors.
2—Goodman 865 Loaders, 26″, on Crawlers.
1—Goodman 665 Loader, on Crawlers, rebuilt.
2—Goodman 660 Loaders, 440 V. A.C., perfect.
1—Goodman 660 Loader, on Crawlers, 250 V. D.C.
1—Goodman 460, on track, rebuilt, all hydraulic.
2—Jeffrey 61 CLR's on rubber, 26″.
3—Jeffrey L-500 Loaders.
2—Myers Whaley, No. 3 Automatic Loaders.
2—Clarkson Loaders, 26″ above rail.

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1—Acme self-propelled rubber tired compressors, 130 cu. ft.
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300—Mine Cars, end dump and drop bottom, 20″ high, 48″ ga.
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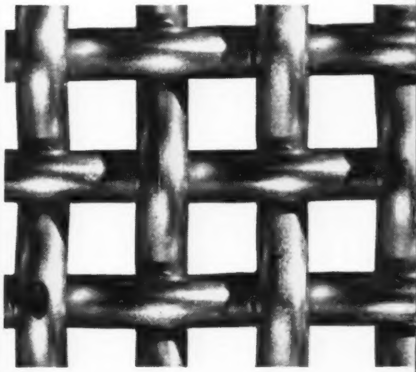

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